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ROTOR SYSTEM EVALUATION
PHASE I

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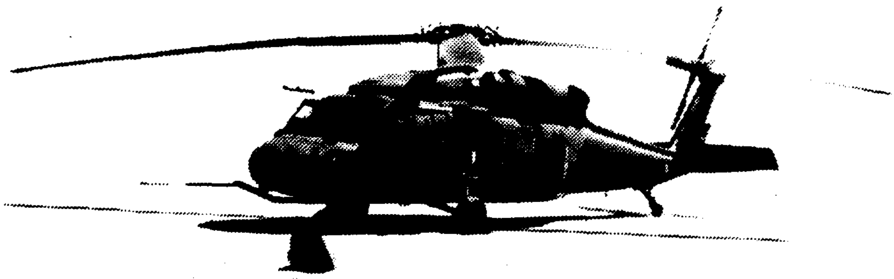

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19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

Flight testing was conducted on a UH-60A Black Hawk helicopter in support of the NASA-Ames Modern Technology Rotors program to provide and validate the technology, acoustics, handling qualities and cost of civil and military rotorcraft. In cooperation with the Rotorcraft Flight Investigations Branch of NASA-Ames Research Center and the U.S. Army Aviation Research and Technology Activity, the U.S. Army Aviation Engineering Flight Activity (AEFA) conducted flight tests totalling 31 productive flight hours between 9 January and 2 June 1987. This report summarizes the flight tests accomplished, test conditions, data, and techniques used to obtain the data. Data measurements included: atmospheric and aircraft state parameters; main rotor blade structural loads, positions and accelerations; flight control positions and structural loads; main rotor hub accelerations and various vibration measurements for the aircraft cabin floor. The handling qualities data in this report, although not representative of a UH-60A in typical operating conditions, were similar to

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previous AEFA test results in similar configurations. The power required for level flight and hovering out-of-ground effect also agreed with results of previous AEFA test programs. (SDW)

TABLE OF CONTENTS

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INTRODUCTION

BACKGROUND

1. The National Aeronautics and Space Administration (NASA)-Ames Research Center, in cooperation with the U.S. Army Aviation Research and Technology Activity (ARTA) is engaged in the Modern Technology Rotors (MTR) program to provide and validate the technology, acoustics, handling qualities and cost of civil and military rotorcraft (ref 1, app A). The MTR program includes a series of investigations of several state-of-the-art rotor systems. The rotor system of the UH-60A Black Hawk helicopter is one of the state-of-the-art rotor systems to be investigated in two phases. The first phase investigated the aerodynamic performance limits and characteristics of the UH-60A using a main rotor blade instrumented for load, position, and acceleration measurements. The UH-60A rotor system will be modeled on the NASA-Ames developed, Comprehensive Analytical Model of Rotorcraft Aeromechanics and Dynamics (CAMRAD) computer program using data from this first phase. The flight test data will be used to verify results predicted from the CAMRAD computer program. As a result of NASA-Ames request for assistance, the U.S. Army Aviation Systems Command (AVSCOM) directed the U.S. Army Aviation Engineering Flight Activity (AEFA) to conduct the phase I flight evaluation in conjunction with NASA-Ames and ARTA (ref 2, app A). The data from this investigation will also be used to provide a technical data base, verify present analytical prediction methods and support near-term developments such as the light helicopter experimental (LHX) development program. The second phase is planned to be conducted when a specially manufactured main rotor blade, extensively modified for numerous surface pressure measurements, is available.

TEST OBJECTIVES

2. The objectives of the phase I evaluation for AEFA are:

a. to obtain flight data for correlation with CAMRAD predictions and for inclusion in a NASA-Ames rotor limit survey;

b. to obtain rotor aerodynamic performance limitations and characteristics;

c. to assist NASA-Ames and ARTA in measuring inflight acoustic signatures of the UH-60A; and

d. to obtain airframe and main rotor hub vibration data.

3. NASA-Ames and ARTA will model the UH-60A rotor system on the CAMRAD computer program, verify the program's predictive capability and isolate any weaknesses as a separate objective from AEFA.

DESCRIPTION

4. The UH-60A Black Hawk helicopter is a twin-turbine, single-main rotor helicopter capable of transporting cargo, 11 combat troops, and weapons during day, night, visual meteorological conditions, and instrument meteorological conditions. Conventional wheel-type landing gear are provided. The main and tail rotors are both four-bladed. Manual main rotor blade and tail pylon folding capabilities are provided for air transportability. A moveable horizontal stabilizer is located on the lower portion of the tail rotor pylon. The helicopter is powered by two T700-GE-700 turboshaft engines each having an uninstalled thermodynamic rating (30 minutes) of 1553 shaft horsepower (shp) (power turbine speed of 20,900 rpm) at sea level, standard day static conditions. Installed dual-engine power is transmission limited to 2828 shp.

5. The UH-60A helicopter (USA S/N 83-23748) used for this evaluation was a sixth year production Black Hawk which incorporated the External Stores Support System fixed provisions and fairings, the reoriented production airspeed probes, and the modified production stabilator schedule. A more detailed description of the UH-60A is available in appendix B, the Prime Item Development Specification (ref 3, app A) and the operator's manual (ref 4).

TEST SCOPE

6. The major portion of the flight testing was conducted at Edwards Air Force Base, California (2302 feet). Portions of the testing were conducted at Bakersfield, California (488 feet) after the authorized flight envelope of the UH-60A helicopter was restricted above 80 knots (ref 5, app A). A total of 39 flights were conducted between 9 January and 2 June 1987, totalling 56.5 flight hours. Total productive flight test time was 31.1 hours. The flight testing was a cooperative effort among NASA-Ames, ARTA and AEFA, where NASA-Ames and ARTA established flight test data requirements and provided technical assistance and AEFA conducted the flight testing and was responsible for data reduction to a format compatible with NASA-Ames requirements. Flight restrictions and operating limitations observed throughout the evaluation are contained in the operator's manual (ref 4), airworthiness release issued by AVSCOM (ref 6), and safety of flight message (ref 5).

Testing was conducted in accordance with the test plan (ref 7) at the conditions shown in tables 1 and 2. Maneuvering limits testing was expanded from the test plan at the request of NASA-Ames and with AVSCOM approval to include additional thrust coefficient to solidity ratios.

TEST METHODOLOGY

7. The flight test data were recorded by hand from test instrumentation displayed in the cockpit, by on-board magnetic tape recording equipment and via telemetry to the Real Time Data Acquisition and Processing System. A detailed listing of test instrumentation is contained in appendix C. Airspeed calibration data was supplemented by test data from previous AEFA evaluations (refs 8 and 9, app A). Flight test techniques and data reduction procedures are described in appendix D.

RESULTS AND DISCUSSION

GENERAL

8. Flight test data were obtained for the Rotorcraft Flight Investigations branch of NASA-Ames Research Center, the U.S. Army Aviation Research and Technology Activity and the U.S. Army Aviation Systems Command in support of the modern technology rotor program. Flight test data included: atmospheric and aircraft state parameters; main rotor blade structural loads, position and accelerations; flight control positions and structural loads, main rotor hub accelerations and various vibration measurements for the aircraft cabin floor. This report summarizes the flight tests accomplished, test conditions, data, and techniques used to obtain the data. The tests and test conditions are presented in tables 1 and 2. Several qualifications are necessary to use and analyze the data obtained during this investigation. The test flights were conducted ball-centered except at airspeeds below 30 knots true airspeed where zero lateral speed was maintained. The test aircraft was tested in a normal utility configuration (fig. 1) at an aft longitudinal center of gravity. Referred rotor speed (ratio of actual main rotor speed to temperature ratio) was maintained constant at 258 rpm. The stability augmentation system (SAS) of the automatic flight control system was OFF for the level flight performance and dynamic stability tests. The pitch bias actuator was centered and electrically disconnected for all flight tests. Because of these requirements and special piloting techniques used to obtain data in maneuvering flight, the aircraft was flown, either in a highly degraded mode or specifically to acquire quantitative structural loads and acceleration data. The handling qualities data in this report are not necessarily representative of the flying qualities of the UH-60A in normal operating conditions but are similar to previous AEFA test results. The power required for level flight and hovering out-of-ground effect obtained during this investigation agreed with results of previous AEFA test programs.

PERFORMANCE

Level Flight Performance

9. Level flight performance tests were conducted at the conditions listed in table 1 to obtain measurements of various main rotor blade loads and to determine the power required for level flight as a function of airspeed and the ratio of thrust coefficient to main rotor solidity (C_T/σ). The target C_T/σ was obtained by maintaining referred gross weight and rotor speed constant. This method requires increasing altitude as gross weight decreases due to fuel consumption and adjusting

Table 1. Test Conditions[1]

Test	C_T/σ [Note 2]	Pressure Altitude[3] (ft)	Calibrated Airspeed[4] (kt)	Remarks
Level Flight Performance[5]	0.08		-2 to 144	
	0.09		-4 to 148	
	0.10	4000 to 6500	-5 to 144	
Climb and Powered Descent Performance	0.08		138 to 169	
	0.09		129 to 179	
	0.10		130 to 161	
Maneuvering Flight Characteristics	0.08	6140	122	
	0.09 0.10	7900 to 9180	122, 140, 150, 160, 171	Up to 2 g's
Dynamic Stability[5]	0.08		66 and 140	4 axes
Acoustic Survey[6]	0.08	4000 to 6500		See table 2
Airspeed Calibration	[Note 7]	2220	-10 to 50 [Note 8]	Low airspeed system forward and aft
			-10 to 10 [Note 8]	Sideward
		2220 and 5100 to 6180	120 to 190	Nose boom system

NOTES:

1Testing was conducted with an aft longitudinal center of gravity (fuselage station 361.0) and mid lateral center of gravity with the automatic flight control systems on unless otherwise noted, and at a referred main rotor speed of 258 rpm.

2C_T/σ: Ratio of thrust coefficient to main rotor solidity ratio:

$$GW/\rho A(\Omega R)^2/\sigma$$

3Altitude and/or gross weight were adjusted to maintain C_T/σ constant.

4Minus sign indicates rearward flight.

5Tests were conducted with stability augmentation systems and force trim OFF.

6Acoustic measurements were recorded in flight by NASA-Ames YO3 Aircraft.

7Gross weight of 16,000 pounds.

8True airspeed.

Table 2. Acoustics Test Conditions[1]

Calibrated Airspeed (kts)	Rate of Descent (ft/min)	Positions from Recording Aircraft
60	0, 400	Left, Trail, Right
	800	Left
80	0	Left, Trail, Right
	400	Left, Right
	800	Left
100	0	Left, Trail
	400	Trail
	800	

NOTES:

[1]Test conditions: Thrust coefficient/rotor solidity ratio = 0.08 average gross weight 15,430 lb. Referred main rotor speed = 258.0 rpm. Average density altitude = 5100 ft. Outside air temperature = 23.0 deg C. Tests were conducted with the Automatic Flight Control Systems ON.

actual rotor speed as outside air temperature varies. Variations in C_T/σ were attained by adjusting the aircraft takeoff gross weight and use of a nominal 5000 feet pressure altitude. This altitude was used to provide comparable data with the high speed climb and powered descent performance tests (para 11). Techniques used in obtaining and analyzing the level flight performance data are described in detail in appendix D. In addition, all the level flight performance data were obtained with SAS OFF, and the pitch bias actuator centered and electrically disabled. This was to simplify the intended computer modeling of the UH-60A flight control system for users of the data. Power required data was corrected for estimated drag of external test instrumentation, and instrumentation electrical load, as obtained from AEFA Final Report Project No. 83-24 (ref 8, app A).

10. Nondimensional test results are presented in figures E-1 through E-4 and dimensional results are presented in figures E-5 through E-7, appendix E. The data for the UH-60A, tested at an aft center of gravity location (fuselage station 360.5), and compared to previous AEFA test results (ref 8, app A) showed an increase in drag of approximately 2 ft^2 equivalent flat plate area. The low speed omnidirectional airspeed system (para 5, app C), installed on the test aircraft for this investigation, probably accounts for this drag increase. The power required data presented was not corrected for this configuration difference so that the power required would be consistent throughout this report. The level flight test data with this explainable difference agreed with results from previous AEFA test programs. The data obtained at an out-of-ground effect hover using the low speed omnidirectional airspeed system agrees with the previously obtained tethered and free flight hover data (refs 8 and 9, app A).

Climb and Powered Descent Performance

11. High speed climbs and powered descents using intermediate rated power were conducted at the test conditions presented in table 1 to verify and extend the level flight performance and to obtain measurements of main rotor blade loads, flight control loads, main rotor blade and hub accelerations and main rotor blade positions. The test technique was similar to that used for level flight performance; however, SAS was ON. Fixed collective control was maintained during the stabilized climb or descent. Details of the test technique are provided in appendix D. Test data was acquired for an altitude band equivalent to $\pm 1\%$ of the aim C_T/σ. Takeoff gross weight was adjusted to allow 5000 feet pressure altitude to be the nominal test altitude for each C_T/σ so that the maximum never exceed airspeed (V_{NE}) limits were available.

12. The test data in terms of tapeline rate of climb and descent as a function of true airspeed are presented in figure E-8, appendix E. The climb and powered descent data was used to extrapolate level flight performance data to 200 knots true airspeed. The tapeline rate of climb or descent was used to calculate level flight power required as discussed in appendix D. The results are presented in figure E-9, appendix E. This data indicates that a UH-60A helicopter at a gross weight of 16,455 lb, 5000 ft standard day conditions would require over 4600 shaft horsepower for level flight at 200 knots true airspeed.

HANDLING QUALITIES

Trimmed Forward Flight Characteristics

13. Flight control positions and aircraft attitude data were obtained in conjunction with the level flight, climb and powered descent performance tests and are presented in figures E-10 through E-13. The trends of control positions and aircraft attitudes with airspeed were similar to those obtained in previous AEFA evaluations for a UH-60A helicopter in the normal utility configuration.

14. One main rotor blade was instrumented to measure flapping, lead-lag and pitch angles. Several problems with the measuring equipment especially the lead-lag measurements precluded the complete assessment desired. The measured main rotor blade angle data that was obtained are presented in figures E-14 and E-15.

Maneuvering Flight Characteristics

15. Steady turns using power required for level flight at a predetermined C_T/σ and airspeed were accomplished at the test conditions listed in table 1 to determine main rotor blade and flight control system loads up to the maximum allowable and obtainable load factor. Flight control position data are presented in figures E-16 through E-25, appendix E. Main rotor blade positions in turning flight are presented in figures E-26 through E-30. Flight control loads are discussed in paragraphs 18 and 19. At all airspeeds below the never exceed airspeed, the gradient of longitudinal control position versus load factor (stick fixed maneuvering stability) was shallow but positive up to 1.9 g's (the highest, repeated load factor tested). At the never exceed airspeeds, the stick fixed maneuvering stability for right turns above 1.5 g's was negative but not objectionable. At load factors higher than 1.4 g's, at all airspeeds, the pilot workload was high. To obtain the 5 to 10 seconds of stabilized flight at

these test conditions, both the pilot and copilot were required to coordinate flying tasks to control and stabilize the aircraft. The test techniques devised and followed for these tests are described in appendix D.

Dynamic Stability

16. The dynamic stability characteristics were evaluated at the conditions listed in table 1. Flight control doublets of approximately 1.0 inch were used to investigate the aircraft response in each axis. These tests were accomplished with SAS OFF with the aircraft trimmed in level flight at constant aim values of C_T/σ and $N/\sqrt{\theta}$. Time histories of these doublets are presented in figures E-31 through E-45, appendix E. Initial aircraft response to longitudinal or lateral doublets was about the pitch and roll axes. The initial response to directional or collective control doublets was about the yaw axis and in rotor speed. After the initial response, all control doublets resulted in a three axis divergence.

STRUCTURAL DYNAMICS

Vibration Survey

17. Vibration data were measured and recorded throughout the test program at the various aircraft stations and axes presented in paragraph 1, appendix C. The vibration characteristics at the main rotor 1/rev and 4/rev frequencies are presented in figures E-46 through E-94, appendix E for level flight, high speed climbs and descents and for maneuvering flight. Rotor speed, although within the normal operating limits, was not maintained constant at 258 rpm but at a constant referred rotor speed of 258 rpm. A moveable ballast cart system was installed on the floor of the cargo area (fig. D-3, app D) for all test flights. This ballast system has an unknown influence on the vibration characteristics of the cabin area; however, qualitative comments by the crew indicated the vibration levels perceived at their stations were representative of a typical UH-60A.

Structural Loads Survey

18. Structural loads data for several components of the flight control system and a main rotor blade were measured and recorded throughout the test program. Average mean and oscillatory load values are presented in figures E-95 through E-129 for level flight, high speed climb and powered descent, and for maneuvering flight. During the powered descents near V_{NE} the pitch change

link control loads exceeded the endurance limit used for the rotating swashplate (±1700 lb) for C_T/σ's of 0.08 and 0.09. During the maneuvering limits testing, this endurance limit was exceeded for all airspeeds tested at a C_T/σ of 0.10 and over 1.6 g's normal acceleration. Furthermore, varying the airspeed from 122 KCAS to 171, the normal acceleration where the pitch change link endurance limit was reached was reduced from 1.6 to 1.2 g's. The do not exceed peak compression load for the rotating swashplate is 10,000 lb. The do not exceed oscillatory limit at zero mean load is 7800 lb.

19. The main rotor forward stationary swashplate link load exceeded the endurance limit for the main support bridge assembly (forward link 2350 lb, aft link 2000 lb) during the maneuvering tests at normal accelerations greater than 1.5 g's. The main rotor aft stationary swashplate link load exceeded its endurance limit during the maneuvering tests at normal accelerations generally greater than 1.8 g's for the 0.10 C_T/σ tested. The do not exceed peak compression load for the main rotor forward and aft stationary swashplate link is 11,000 lb. The do not exceed oscillatory limit at zero mean load is 8500 lb for the forward link and 7500 lb for the aft link.

20. Main rotor blade spar normal and edgewise loads at various positions along the span were measured and recorded during the entire test program. These loads as well as the measured aft lower spar corner stresses are presented in figures E-123 through E-129, appendix E. Several parameters were not functional for the entire program due to instrumentation equipment failures. These were eliminated from the figures in appendix E.

ACOUSTIC SURVEY

21. An external acoustic survey was conducted at the test conditions presented in table 2. Acoustical measurements were taken in level flight, descents and hover at various positions relative from the test aircraft. Support for this test was provided by NASA-Ames Research Center using a specially equipped YO-3A aircraft for the inflight noise measurements. Test results will be published as a separate report by NASA-Ames Research Center.

CONCLUSIONS

22. The power required for level flight and hovering out-of-ground effect obtained during this investigation agreed with results of previous AEFA test programs (para 10).

23. Level flight power required was calculated from high speed powered descent data and indicated over 4600 shaft horsepower would be required to fly the UH-60A at 200 knots true airspeed at 5000 ft standard day conditions and a gross weight of 16,455 lb (para 12).

24. The trends of control positions and aircraft attitudes in level and climbing flight, powered descents, and turning flight are similar to those obtained in previous AEFA evaluations, where comparable (paras 13, 15, and 16).

25. Special test techniques were required to obtain the maneuvering flight characteristics data (para 16 and paras 17 and 18, appendix D).

26. Endurance limits were exceeded for the main rotor pitch change link and forward and aft stationary swashplate links at various combinations of high forward airspeed in descending, and turning flight (paras 18 and 19).

RECOMMENDATIONS

27. None.

APPENDIX A. REFERENCES

1. NASA/Army Black Hawk (UH-60) Rotor Project Plan, NASA-Ames Research Center.

2. Letter, AVSCOM, AMSAV-ED, 21 August 1985, subject: Evaluation of the Limits of the UH-60A Black Hawk Helicopter Rotor System. (Test Request)

3. Prime Item Development Specification, Sikorsky Aircraft Division, DARCOM CP-2222-S1000F, 18 December 1981.

4. Technical Manual, TM 55-1520-237-10, *Operator's Manual, UH-60A Helicopter*, Headquarters Department of the Army, 21 May 1979 with change 41 dated 7 May 1987.

5. Safety of Flight Message 112000Z Apr 87, subject: Safety of Flight Message, Operational, RCSCSGLD-1860 (R1) UH-60A/EH-60A Series, Stabilator Operational Procedures UH-60-87-05.

6. Letter, AVSCOM, AMSAV-ED, 8 January 1986, subject: Airworthiness Release of UH-60A Black Hawk Helicopter S/N 82-23748 to conduct a Flight Evaluation of the UH-60A Helicopter Rotor System AEFA Project No. 85-15 Rotor System.

7. Test Plan, AEFA Project No. 85-15, *Rotor Limits Evaluation, Phase I, UH-60A Black Hawk Helicopter*, December 1985

8. Final Report, AEFA Project No. 83-24, *Airworthiness and Flight Characteristics Test of a Sixth Year Production UH-60A*, June 1985.

9. Final Report, AEFA Project No. 86-01, *Level Flight Performance Evaluation of the UH-60A Helicopter with the Production External Stores Support System and Ferry Tanks Installed*, September 1986.

10. Technical Manual, TM55-1520-237-23-2, *Aircraft General Information Manual, UH-60A Helicopter*, Headquarters Department of the Army, 29 December 1978.

APPENDIX B. AIRCRAFT DESCRIPTION

GENERAL

1. The Sikorsky UH-60A (Black Hawk) is a twin-turbine engine, single-main rotor helicopter capable of transporting 11 combat troops plus a crew of three, cargo and weapons during day, night, visual and instrument conditions. It is equipped with three nonretractable conventional wheel-type landing gear. A movable horizontal stabilator is located on the lower portion of the tail rotor pylon. The main and tail rotors are both four-bladed with a capability of manual main rotor blade and tail pylon folding. The cross-beam tail rotor with composite blades is attached to the right side of the pylon and is canted 20 degrees upward from the horizontal. A complete description of the aircraft is contained in the operator's manual (ref 4, app A) and the aircraft general information manual (ref 9). The test aircraft U.S. Army Serial Number 83-23748, is a sixth year production aircraft incorporating fixed provisions for the external stores support system and support brackets for the AN/ALQ-144(V) infrared countermeasures set and M-130 chaff/flare dispenser. The empty weight of the test aircraft was 11,673 lb at fuselage station 357.8. The fuel capacity using gravity refueling method is 364 gallons. Figures B-1 through B-7 depict the test aircraft configured for this test. Major features of the flight control system are described below.

FLIGHT CONTROL SYSTEM

General

2. The UH-60A utilizes conventional helicopter cyclic, collective, and directional controls powered by a triply redundant 3050 PSI hydraulic system. The pilot and copilot controls have separate paths to a combining linkage for each control axis. The control inputs from the cockpit controls are transmitted by mechanical linkage to hydraulic servos for power assist and then to the mixing unit. The mixing unit combines, sums, and couples the cyclic, collective, and yaw inputs and provides proportional output signals to the main and tail rotor controls. Pilot control is assisted by an Automatic Flight Control System (AFCS) comprised of five basic subsystems: Stabilator, Pitch Bias Actuator (PBA), Stability Augmentation System (SAS), Trim System, and Flight Path Stabilization (FPS).

Figure B-1. Test Aircraft - Front View

Figure B-2. Test Aircraft - Left Front Quartering View

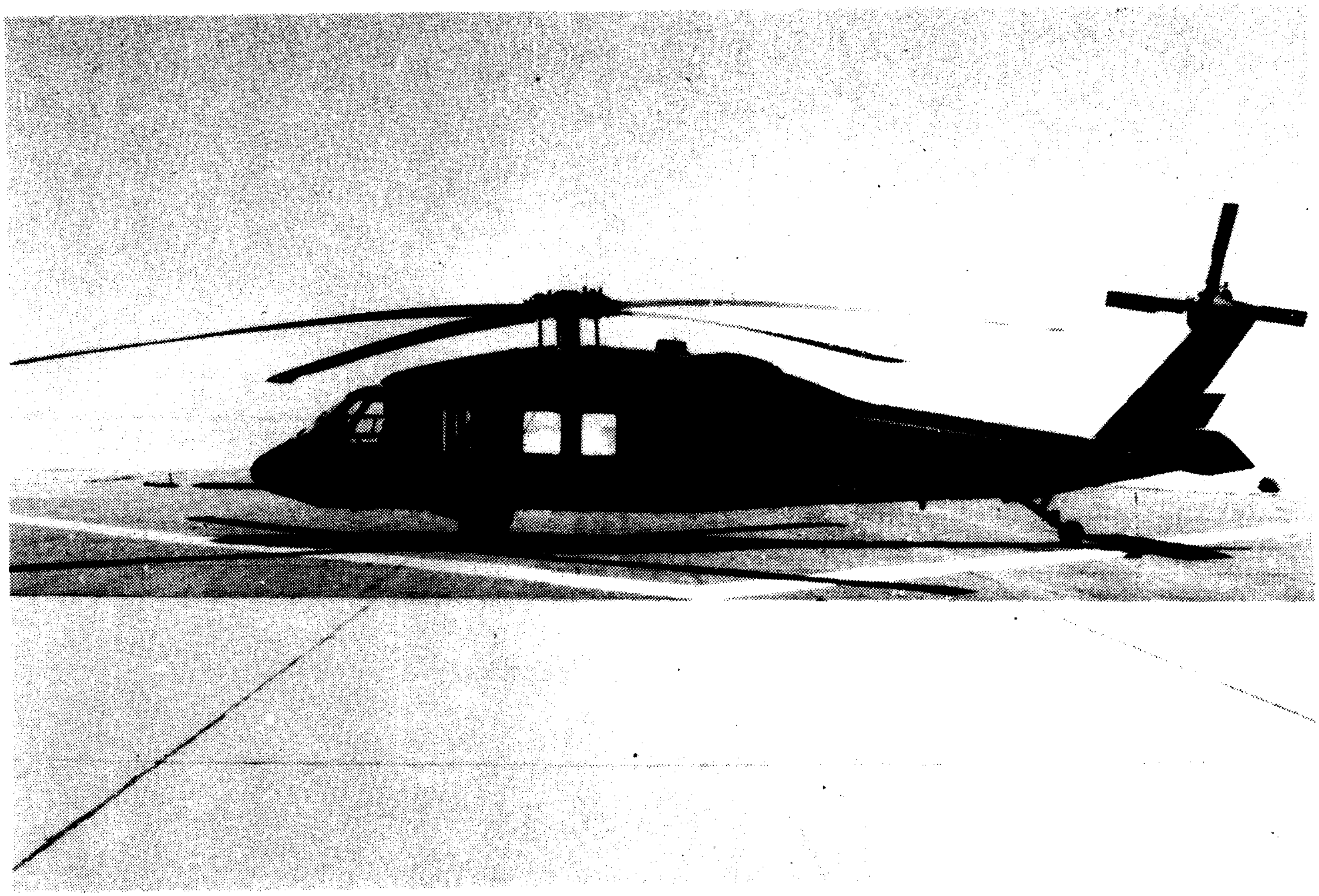


Figure B-3. Test Aircraft - Left Side View

Figure B-4. Test Aircraft - Left Rear Quartering View

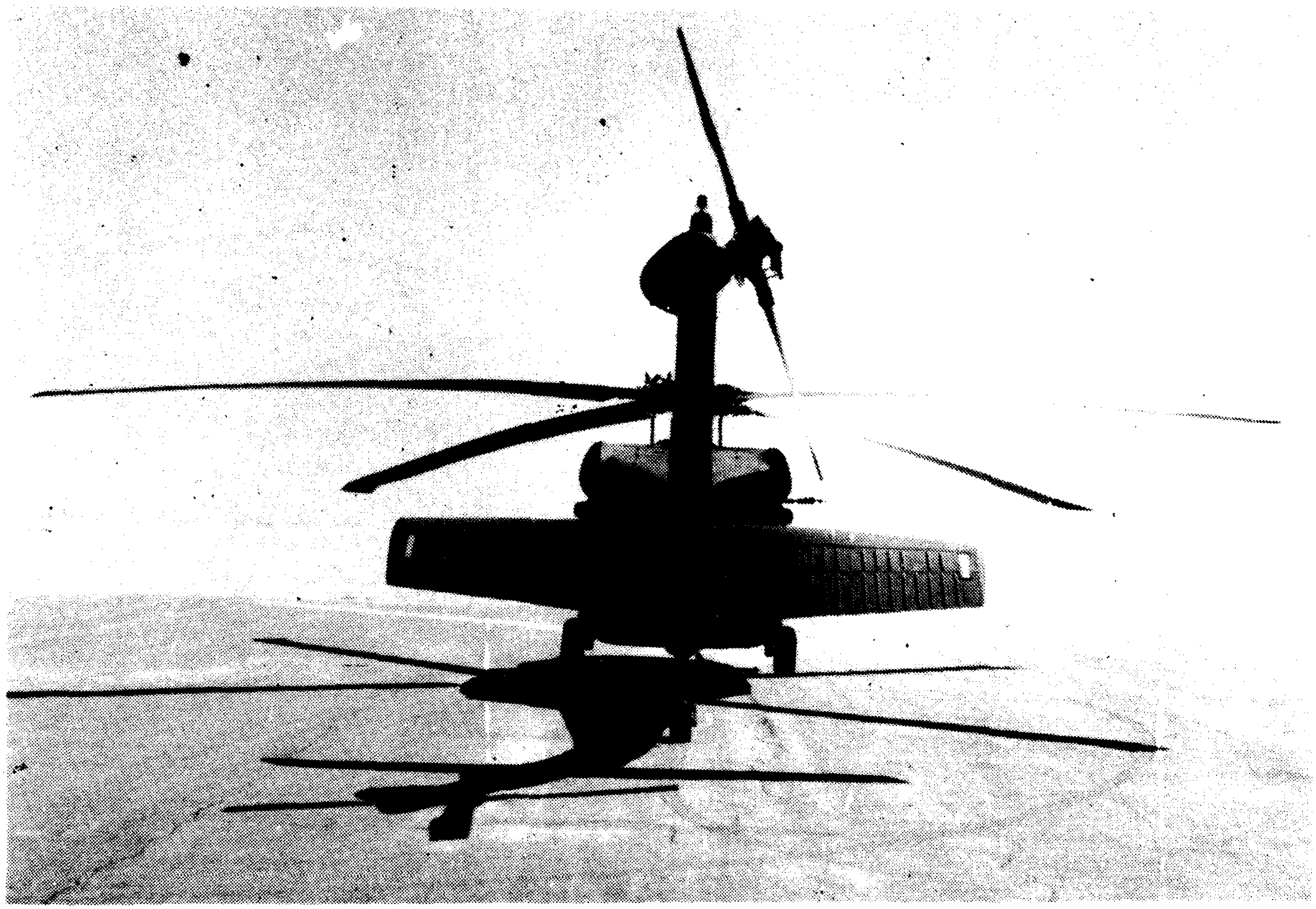


Figure B-5. Test Aircraft - Rear View

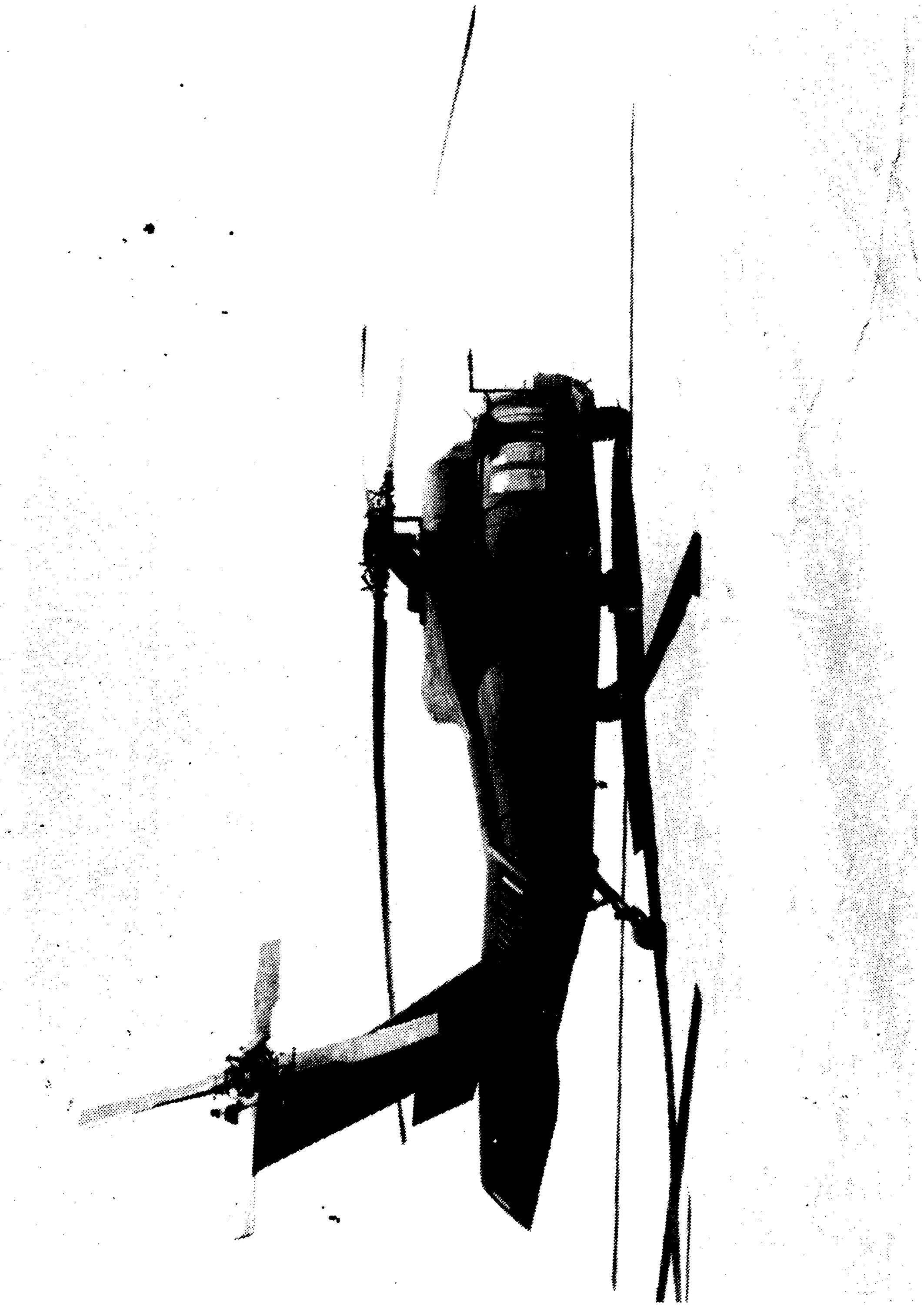


Figure B-6. Test Aircraft - Right Rear Quartering View

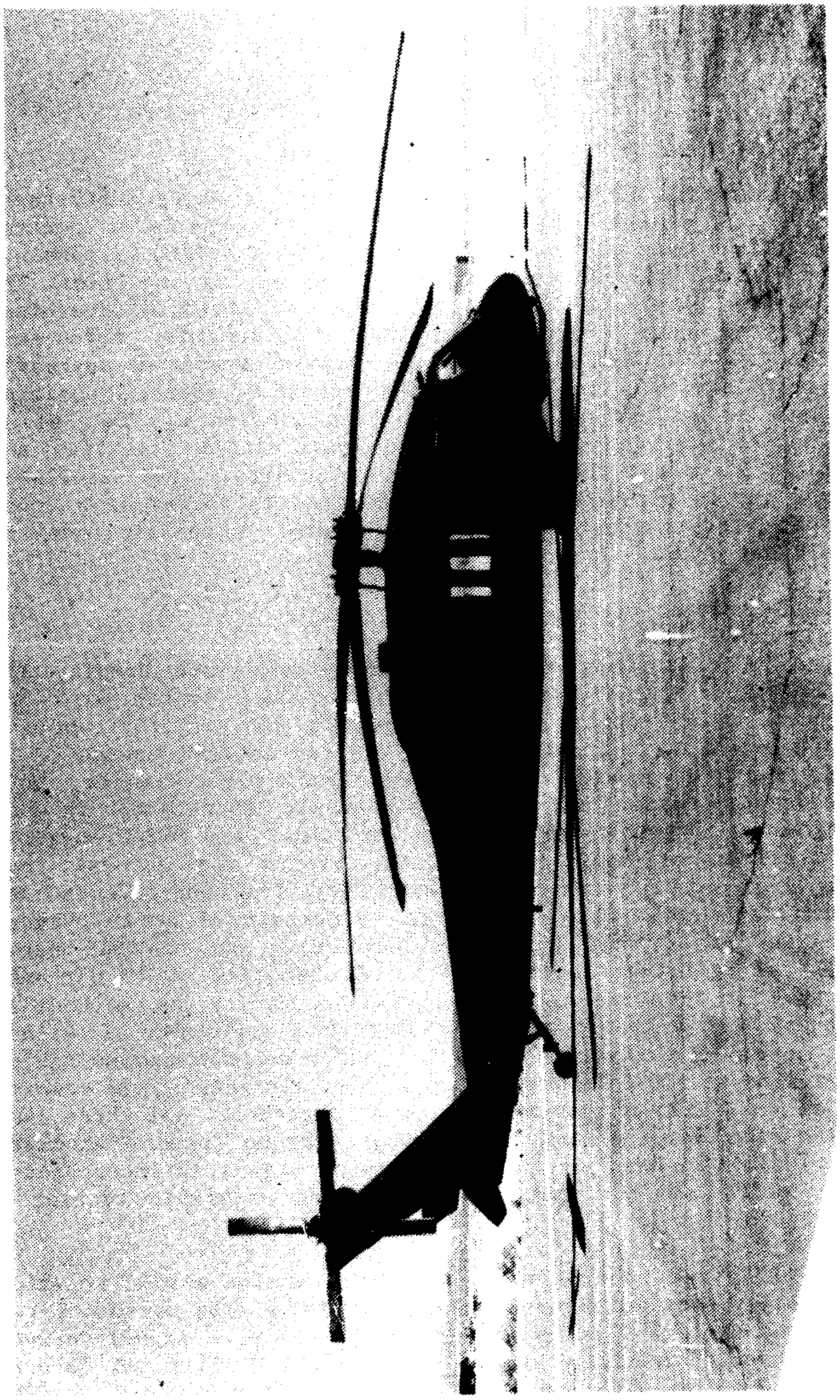


Figure B-7. Test Aircraft - Right Side View

Automatic Flight Control System

General:

3. The Sikorsky UH-60A AFCS consists of five major subsystems: the SAS, FPS system, trim system, PBA, and stabilator control system. Electronic control of the systems is provided by commands from a digital SAS/FPS computer and a SAS analog amplifier. The SAS provides three-axis rate damping, pseudo attitude retention, and limited turn coordination. The FPS provides three-axis attitude and airspeed hold and is the primary source of automatic turn coordination. The trim system provides control position hold and control forces versus position gradients. The PBA is designed to provide positive static longitudinal stability and contributes to positive maneuvering stability. The stabilator control system automatically positions the stabilator as a function of flight parameters to tailor aircraft pitch attitude and dynamic response.

Stability Augmentation System:

4. The SAS functions to provide three-axis rate damping and pseudo attitude retention. The SAS is a dual system with one subsystem (SAS-1) controlled by the analog SAS amplifier and one subsystem (SAS-2) controlled by the digital SAS/FPS computer. It is redundant in sensors and command signal path; however, both SAS subsystem command signals drive a single SAS actuator in each axis. During normal operation with both SAS-1 and SAS-2 engaged, each provides one-half of the total system nominal gain and one-half of total system control authority. The control authority of each is electrically limited to ± 5 percent of total control travel in pitch, roll, and yaw. SAS inputs to the SAS servo valves are additive to provide a total authority of 10 percent. The sum is limited to ± 10 percent authority by mechanical limits of SAS actuator travel. Selectable operation of either SAS-1 or SAS-2 is available at the center console and switching either subsystem OFF automatically doubles the gain of the remaining SAS while its authority remains at 5 percent. All three axes provide rate damping and lagged rate damping (pseudo attitude retention). A washout of the rate damping signal is incorporated in the pitch and yaw channels to prevent saturation during a steady turn.

5. The SAS-1 is controlled by the SAS-1 analog amplifier which continuously derives commands based on inputs from the No. 1 yaw rate gyro, the No. 1 pitch rate gyro, a roll rate signal derived from the No. 2 vertical gyro, and the No. 1 filtered lateral accelerometer signal. The SAS-2 is controlled by the SAS/FPS

digital computer. SAS-2 commands are continuously generated in response to signals from the roll rate gyro, No. 2 pitch rate gyro, signals derived from magnetic compass gyros (yaw rate), No. 1 vertical gyro (pitch and roll rate), and No. 1 filtered lateral accelerometers. At airspeeds above 60 knots indicated airspeed (KIAS), input signals from the No. 1 filtered lateral accelerometer and the No. 1 vertical gyro (derived rate) are provided to the SAS-2 system to stabilize yaw during coordinated turns.

6. SAS-2 operation is continuously monitored by the SAS/FPS computer. This monitor system compares inputs from independent sources to SAS command and to SAS actuator output. Failure of any of these comparison checks in SAS-2 input or output indicates a SAS-2 failure (pitch, roll, or yaw channel) and the control input from the affected channel will be removed (actuator remains at failed position) and the SAS-2 advisory light will be illuminated. SAS-1 does not contain fault detection logic.

Flight Path Stabilization System:

7. The FPS is primarily an aircraft attitude hold system that incorporates conditional capability for airspeed hold and turn coordination. The FPS works through the roll, pitch, and yaw trim actuators. The FPS can drive the cockpit control to any position to which the pilot/copilot can move the controls, resulting in a 100 percent FPS parallel control authority. The AFCS limits the rate of FPS within the maximum override force limits stated in the trim system section. Since FPS inputs drive the cockpit controls through the trim actutors, the TRIM must be ON in order to have FPS.

8. The attitude hold function of the FPS is designed to maintain a desired heading or pitch and roll attitude. The trim attitude, once established, is automatically maintained unless changed by the pilot. At airspeeds greater than 60 KIAS the pitch axis of the FPS seeks to maintain the airspeed for which the trim attitude has been established. When the reference pitch attitude is changed a time delay in the airspeed hold function allows time to stabilize at the new trim airspeed prior to initiating the airspeed hold function. During this time the attitude hold function maintains the pilot-selected pitch attitude.

9. The FPS provides two yaw channel functions: heading hold and automatic turn coordination. For heading hold (below 60 KIAS), the aircraft is maneuvered to the desired heading with the pilot's or copilot's feet depressing one or both of the pedal switches. When the pilot or copilot removes his feet from the switches the

aircraft automatically maintains that reference heading. At airspeeds greater than 60 KIAS the coordinated turn feature of the FPS is operational. The coordinated turn feature is initiated by a lateral stick displacement of approximately 1/2 inch and a bank angle of greater than 2 degrees. The feature is disengaged when the bank angle is less than 1 degree and the roll rate is less than 2 degrees per second. Turn coordination is accomplished by directional control inputs through the yaw trim actuator to zero the side force as sensed by the lateral accelerometers in the stabilator control system. At airspeeds greater than 60 KIAS, heading hold is automtically engaged unless the pilot engages the turn coordination feature.

10. The FPS and all inputs are subject to a number of cross-checks, within the computer. In essence, each input (i.e. attitude, rate, airspeed, etc.) is compared either against another independent source of the same information or, in the case of rate inputs, a computer-derived rate. If these comparisons exceed the preprogrammed tolerance, the malfunctioning portion of the FPS will be disabled and the appropriate AFSC advisory light and the FPS FAIL caution light will be illuminated.

Trim System:

11. The trim system provides zero force control centering at a pilot/copilot selected trim control position, a spring breakout force plus gradient and a pedal damper force. The trim system is selected by activating the push-on push-off switch, marked TRIM, on the AFCS control panel.

12. With the trim system selected OFF there is no control force gradient or control centering in the cyclic control system or directional control system. Directional control movements will be resisted by a pedal damper which generates an opposing pedal force to the proportional rate of pedal movement. This damping force is electrically generated but is continuously engaged without regard to TRIM switch position. With the trim system ON, directional and lateral control forces are developed in the electromechanical trim actuators. These actuators incorporate an electrically controlled rotary spring assembly which allows the pilot to select the zero force control trim position. The designed maximum override force full opposite control position is 80 pounds in directional and 19 pounds in lateral cyclic control. Longitudinal cyclic control forces are developed in an electrohydromechanical pitch trim actuator with a designed maximum override force of 20 pounds.

13. With the trim system selected ON the pilot/copilot may change the cyclic control trim position through two means: a cyclic trim

release switch and a cyclic beep trim switch. The cyclic beep trim switch allows the cyclic control trim position to be changed in one direction at a time at a fixed-rate of travel by electrically driving the trim actuator through the rotary spring assembly. The beep trim switch is a four-position "chinese hat" switch mounted on the cyclic stick grip. Activation of the trim release button switch released the force gradient on the longitudinal and lateral cyclic. The position of the cyclic control when the trim release switch is open (released) becomes the new cyclic trim position. At airspeeds below 60 KIAS, when the pedal switches are closed (any pedal switch depressed), the electronically controlled yaw force gradient spring is repositioned by pedal movement resisted only by the pedal rate damper. When the pilot/copilot removes his feet from the pedals which release the pedal switches, the electronically controlled rotary spring reengages, holding the pedals at the new trim position through the pedal breakout plus gradient spring. Above 60 KIAS the pedal switches and the TRIM REL switch together provide yaw trim release.

14. The SAS/FPS computer monitors the trim system by comparing the commanded trim actuator position to the actual position in all three axes. (Trim actuator position may be commanded by the pilot or by the FPS). If this comparison is out of tolerance, the trim system is shut off in the defective axis and the TRIM FAIL caution light and TRIM advisory light on the AFCS computer are illuminated. The trim system may be reset by pressing both POWER ON RESET buttons on the AFCS control panel.

Pitch Bias Actuator:

15. The PBA is an electromechanical differential actuator built into the longitudinal cyclic control system to assure a stable gradient of longitudinal cyclic control position versus airspeed. It receives airspeed, pitch attitude, and pitch rate inputs from the SAS/FPS computer continuously whenever power is applied to the aircraft assuming the SAS/FPS computer detects no faults prejudicial to PBA function. The AFCS control panel switch configuration will not change the PBA function in normal operation. Airspeed signals do not affect the PBA operation below 80 KIAS. PBA inputs do not feed back to the cockpit controls. PBA is, in effect, a variable length control rod which changes the relationship between longitudinal cyclic control and swashplate tilt. The PBA was centered and electrically disconnected for all test flights.

16. The authority of the PBA is 15 percent of longitudinal cyclic full throw and is limited by the computer to a maximum rate of 3 percent per second. PBA function is monitored by the SAS/FPS

computer by an actuator feedback system. If actuator position differs from the commanded position by more than the predetermined tolerance, power is removed from the PBA, the actuator remains in the position it was in at the time of failure, and the PITCH BIAS FAIL caution light is illuminated. This could result in loss of up to 15 percent (1.5 inches) of forward or aft cyclic control authority. Intermittent PBA failures due to an actuator position versus command "no compare" may be reset by pushing both POWER ON RESET buttons on the AFCS control panel.

17. The PBA operation may be faded or degraded by "no compare" results in airspeed, pitch rate, vertical gyro inputs, internal mechanical failure, or various SAS/FPS computer failures. A pitch rate or vertical gyro failure results in the PBA centering. An airspeed failure results in a constant 120-knot airspeed signal. A mechanical failure of the PBA causes the actuator to remain in the position in which it failed.
Stabilator Control System:

18. The stabilator control system is an electrically controlled and activated system. The primary purposes of the system are to schedule stabilator incidence to eliminate excessively nose-high attitudes at low airspeed due to downwash impingement on the stabilator, and to optimize pitch attitudes for climb, cruise, and autorotational descent. The control system is composed of two analog amplifiers which operate from independent input sources and command the position of two electric jackscrew actuators acting in series. During normal operation these jackscrews operate in unison, with each providing one-half of the stabilator position input.

19. The stabilator position is programmed between 8 ± 2 degrees trailing edge up and 38 ± 4 degrees trailing edge down as a function of four variables: airspeed, collective control position, pitch rate, and lateral acceleration. The airspeed input primarily allows the stabilator to align with the main rotor downwash during low-speed flight, thus reducing the stabilator download and eliminating excessively nose-high pitch attitudes at low airspeed. The collective control input reduces coupling of pitch attitude to collective in forward flight. Pitch rate and lateral acceleration inputs are designed to improve the dynamic respose of the airframe. Pitch rate inputs to the stabilator system provide a degree of pitch rate damping to supplement SAS-commanded damping. The lateral accelerometer inputs by providing an indication of both side force and yaw angular acceleration, decouple the pitch response to tail rotor thrust changes resulting from changes in the inflow through the tilted tail rotor with sideslip variation.

20. The stabilator system is independent of the other AFCS subsystems although it shares common inputs. Collective control position airspeed, and lateral acceleration inputs are all dual inputs which are compared in the AFCS computer and the output of the No. 2 pitch rate gyro is compared with a pitch rate derived in the AFCS computer. If the AFCS computer detects a "no compare" in those inputs, the appropriate caution/advisory lights will be illuminated and affected AFCS computer controlled functions will be shut down; however, the AFCS computer effects no control over the stabilator system function.

21. Stabilator malfunctions are detected and controlled within the stabilator amplifier system. The positions of the two actuators are monitored and compared by rate and position. Any system malfunction which causes a minimum difference in actuator position (10 degrees at airspeeds less than 30 KIAS and 4 degrees airspeeds greater than 150 KIAS) results in an automatic shutdown of power to both actuators. If the malfunction is transient, the stabilator system may be reset by pressing the stabilator AUTO CONTROL RESET button on the AFCS control panel. The pilot may at any time take manual control of the stabilator and control its position by referring to cockpit-mounted stabilator position indicators.

BASIC AIRCRAFT INFORMATION

22. Principal dimensions and general data of the UH-60A helicopter are as follows:

Airframe

Length:

Maximum (rotor blades turning)	64 ft, 10 in.
Fuselage (nose to vertical tail)	50 ft, 0.75 in.
Main rotor to tail rotor clearance	2.8 in.

Width:

Main rotor blades turning	53 ft, 8 in.
Main landing gear	9 ft, 8 in.

Height:

Maximum (tail rotor blades turning)	16 ft, 10 in.
Main rotor clearance (ground to tip, rotor static against stops)	7 ft, 14 in.

Tail rotor clearance (ground to tip, rotor turning)	6 ft, 6 in.
Horizontal Stabilator:	
Span	172.6 in.
Chord - at root - at tip	44.0 in. 30.5 in.
Aspect ratio	4.6
Airfoil section designation root to tip	NACA 0014
Sweep of leading edge, quarter chord	0 deg
Dihedral	0 deg
Range of travel (reference to fuselage water line)	38±4 deg trailing edge down to 8±2 deg trailing edge up
Taper ratio	1.87
Area (total)	45.0 sq ft
Vertical Tail:	
Span	8 ft, 2 in.
Aspect ratio	1.92
Taper ratio	1.623
Sweep angle (1/4 chord line)	41 deg
Airfoil section designation	NACA 0021 to 65 percent span with 7 deg trailing edge camber lower section
Incidence to fuselage reference line	0 deg
Area (total)	32.3 sq ft

Gross Weight

Maximum alternate gross weight	20,250 pounds
Empty weight	Approximately 10,750 pounds
Primary Mission gross weight	16,455 pounds
Fuel capacity	364 gallons

Main Rotor

Number of blades	4
Diameter	53 ft, 8 in.
Blade chord	1.73/1.75 ft
Blade twist	-18 deg (equiv)
Blade tip sweep	20 deg aft
Blade area (one blade)	46.7 sq ft
Geometric disc area (total)	2262 sq ft
Geometric solidity ratio (blade area/disc area)	0.0826
Airfoil section (root to tip) designation	SC1095/SC1095R8
Thickness (percent chord)	9.5 percent
Main rotor mast tilt (forward)	3 deg
Aspect ratio	15.4
Range of flapping	-6 to 25 deg
Blade droop stop angle (static)	-1/2 deg
(flight)	-6 deg

Tail Rotor

Number of blades	4
Diameter	11 ft

Blade chord	0.81 ft
Blade twist (equiv linear)	-18 deg
Blade area (one blade)	4.46 sq ft
Geometric disc area (total)	95 sq ft
Geometric solidity ratio (blade area/disc area)	0.1875
Airfoil section (root to tip designation	SC1095/SC1095R8
Thickness (percent chord)	9.5 percent
Aspect ratio	6.79
Cant angle	20 deg

Main Rotor RPM

	Power On	Power Off
Minimum	234.7	232.1
Normal	245.0 to 260.5	232.1 to 270.8
Maximum	275.9	283.7
Design	257.9	---

Tail Rotor RPM

	Power On	Power Off
Minimum	1082.7	1070.8
Normal	1130.3 to 1201.7	1070.8 to 1249.3
Maximum	1273.1	1308.8
Design	1189.8	---

Gear Ratios

Main Transmission	Input RPM	Output RPM	Ratio	(Teeth)
Input bevel	29,900.0	5747.5	3.6364	(80/22)
Main bevel	5747.5	1206.3	4.7647	(81/17)
Planetary	1206.3	257.9	4.6774	$\frac{(228 + 62)}{62}$

Tail takeoff	1206.3	4115.5	0.2931	(34/116)
Accessory bevel (generator)	5747.5	11,805.7	0.4868	(37/76)
Accessory spur (hydraulics)	11,805.7	7186.1	1.6429	(92/56)
Intermedite Gearbox	4115.5	3318.9	1.2400	(31/25)
Tail Gearbox	3318.9	1189.8	2.7895	(53/19)
Overall				
Engine to main rotor	20,900.0	257.9	81.0419	
Engine to tail rotor	20,900.0	1189.8	17.5658	
Tail Rotor to main rotor	1189.8	257.9	4.6136	

Rotational Speed Signals at 100 Percent

	RPM	Frequency, Hz
Main rotor, N_R	257.89	11,018.6
Power turbine, N_P	20,900	1393.3
Gas producer, N_g	44,700	2135.7

ENGINES

23. The primary power plants for the UH-60A helicopter are General Electric T700-GE-700 front drive turboshaft engines, rated at 1553 shaft horsepower (shp) at a power turbine speed of 20,900 revolutions per minute (rpm) (sea level, standard day installed). The engines are mounted in nacelles on either side of the main transmission. Each engine has four modules: cold section, hot section, power turbine section, and accessory section. Design features include an axial-centrifugal flow compressor, a through-flow combustor, a two-stage uncooled power turbine, and self contained lubrication and electrical systems. Pertinent engine data are shown below.

Model	T700-GE-700
Type	Turboshaft

Rated power	1553 shp installed at sea level, standard-day static conditions at 20,900 rpm
Compressor	Five axial stages, 1 centrifugal stage
Combustion chamber	Single annular chamber with axial flow
Gas generator stages	2
Power turbine stages	2
Direction of engine rotation (aft looking fwd)	Clockwise
Weight (dry)	415 pounds max
Length	47 in.
Maximum diameter	25 in.
Fuel	MIL-T-5624 grade JP-4 or JP-5

APPENDIX C. INSTRUMENTATION

GENERAL

1. The test instrumentation system consisted of calibrated sensors and transducers displayed or recorded on magnetic tape as indicated below. The output from transducers that required signal conditioning were fed through signal conditioning modules that electrically condition each transducer signal to make it compatable with the digitizing and sampling processor. The output of the signal conditioning module is sampled serially, digitized and recorded on the airborne magnetic tape recorder and could simultaneously be transmitted to a ground station. A telemetry antenna was mounted on the underside of the test aircraft tail boom. The test instrumentation was installed, maintained and except for the main rotor blade strain gauge measurements calibrated by the U.S. Army Aviation Engineering Flight Activity. The instrumented main rotor blade and blade position equipment were provided by NASA-Ames. A test boom (fig. C-1), with a swiveling pitot-static tube and angle-of-attack and sideslip vanes, was installed at the nose of the aircraft. An Elliot Low Airspeed Sensing and Indicating Equipment (LASSIE), was mounted on the right side of the aircraft in place of the FM antenna. All other instrumentation was installed inside the test aircraft. Various sensors and transducer installations are shown in figures C-2 through C-9, C-15, C-18, and C-19.

Pilot Panel

Airspeed (boom)
Airspeed (LASSIE)
Altitude (boom)
Altitude (radar)
Rate of climb*
Rotor speed (digital)
Engine torque* **
Control position
- Longitudinal
- Lateral
- Directional
- Collective

Normal acceleration
Angle of sideslip
CG lateral acceleration (sensitive)

*Ship's system/not calibrated
**Both engines

Figure C-1. Test Boom and Elliot LASSIE Installation

Copilot Panel

Event switch
Control fixtures
Airspeed (ship's)†
Altitude (ship's)†
Rotor speed*

Engineer Panel

Fuel used**
APU fuel used
Instrumentation controls
Free air temperature
Time code display
Run number
Event switch

Digital (PCM) Data Parameters

Airspeed (ship)
Airspeed (boom)
Airspeed (LASSIE)
    Longitudinal
    Lateral
    Vertical
Altitude (ship)
Altitude (boom)
Altitude (radar-dual range)
Total air temperature
Rotor speed
Engine fuel totalizer**
Engine fuel flow**
Engine fuel temperature**
Engine output shaft torque**
Turbine exhaust temperature**
APU fuel totalizer
Tail rotor shaft torque (2 measurements)
Tail rotor impressed pitch (blade angle at 0.75 blade span)
Stabilator position
Control position
    Lontitudinal cyclic
    Lateral cyclic
    Directional pedal
    Collective

*Ship's system/not calibrated
**Both engines
†Ship's system/calibrated

Mixer input position
- Longitudinal
- Lateral
- Directional

SAS output position
- Longitudinal
- Lateral
- Directional

Primary servo position
- Forward
- Aft
- Lateral

Attitude
- Pitch
- Roll

Angular Rate
- Pitch
- Roll
- Yaw

Angular Acceleration
- Pitch
- Roll
- Yaw

Linear acceleration
- Center of gravity (cg) - normal
- CG - lateral
- CG - longitudinal

Angle of attack
Angle of sideslip
Aircraft heading
Main rotor 1/rev pulse
Tail Rotor 1/rev pulse
Main rotor hub acceleration
- Vertical
- Radial
- Tangential

Time of day
Run number
Pilot event
Engineer event
Voice

2. The following sensitive instrumentation was provided by NASA-Ames. Interface of the instrumentation to the on board recorder was accomplished by AEFA personnel.

Digital (PCM) Data Parameters

Main rotor lead lag angle
Main rotor flapping angle
Main rotor pitch angle
Main rotor shaft extension bending moment
Main rotor torque
Main rotor swashplate link load
- Forward
- Aft
- Lateral

Main rotor pushrod load
Main rotor blade root normal bending load
Main rotor blade root edgewise bending load
Main rotor spar lower rear bending stress @ 50%, 60% and 70% radius
Main rotor spar normal bending load @ 50%, 70% and 92% radius
Main rotor spar edgewise bending load @ 50% and 70% radius
Main rotor normal acceleration at the tip and root
Main rotor tangential acceleration at the tip

Vibration Accelerometers	Transducer Location (FS)	(BL)	(WL)
Pilot Floor	253.0	31.0	206.7
Longitudinal			
Lateral			
Vertical			
Copilot Floor	253.0	31.0	206.7
Lateral			
Vertical			
Forward Cabin Floor	295.0	±35.5	206.7
Right Side Lateral			
Right Side Vertical			
Left Side Vertical			
Aft Cabin Floor	398.0	±35.0	206.7
Right Side Lateral			
Right Side Vertical			
Left Side Vertical			
Stabilator Tip	702.0	±83.5	247.0
Right Side Longitudinal			
Left Side Longitudinal			
Tail Rotor Gearbox	732.0	0.0	325.0

3. Installations of the cabin floor accelerometers are depicted in figures C-2 through C-6. Instrumentation for the main rotor servo and mixer positions are shown in figure C-7. Figure C-8 shows the instrumentation installed on the main rotor mast extension for mast bending and main rotor torque as well as the

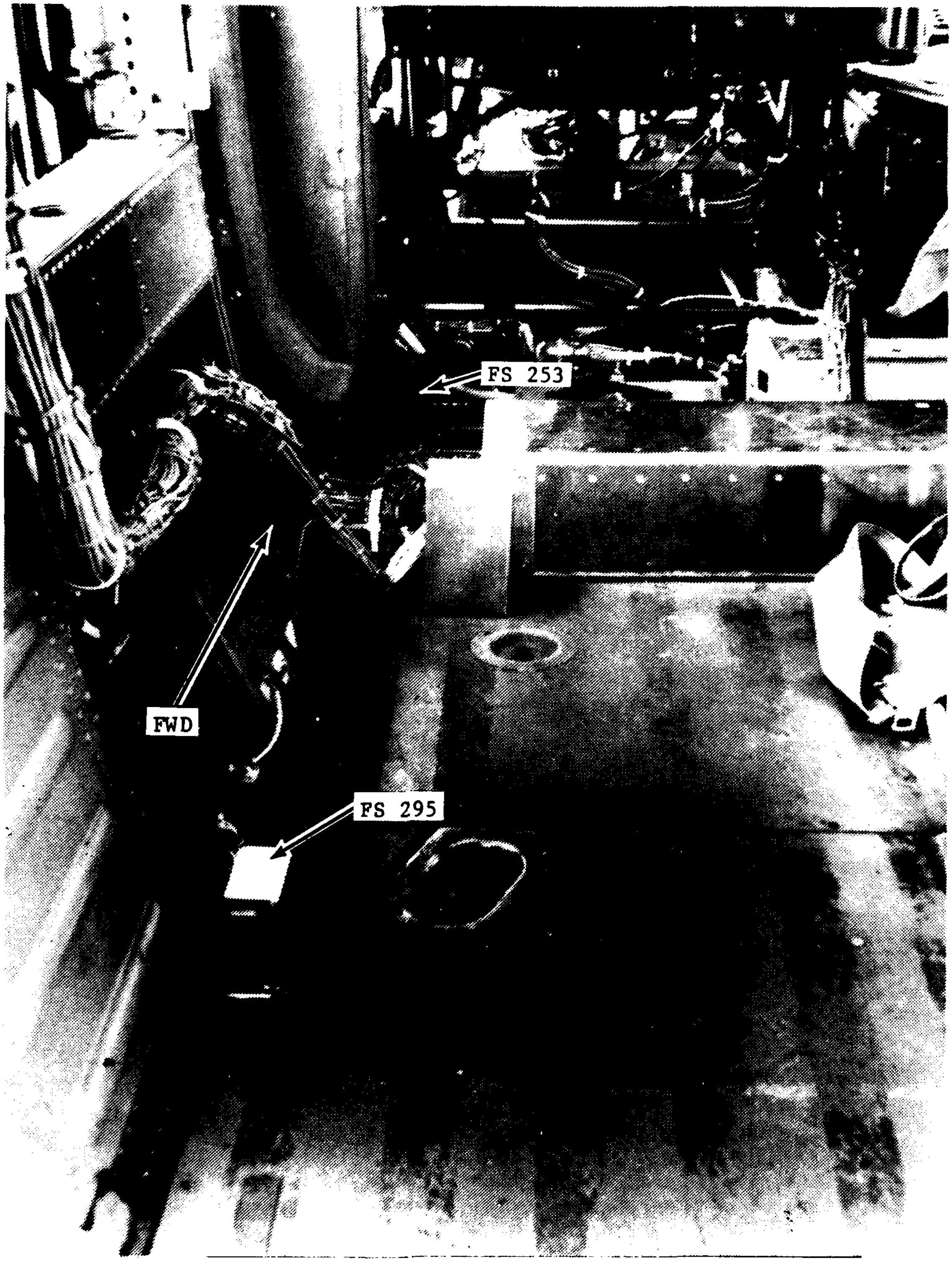


Figure C-2. Aircraft Cabin Floor Vibration Accelerometer Location (Left Side)

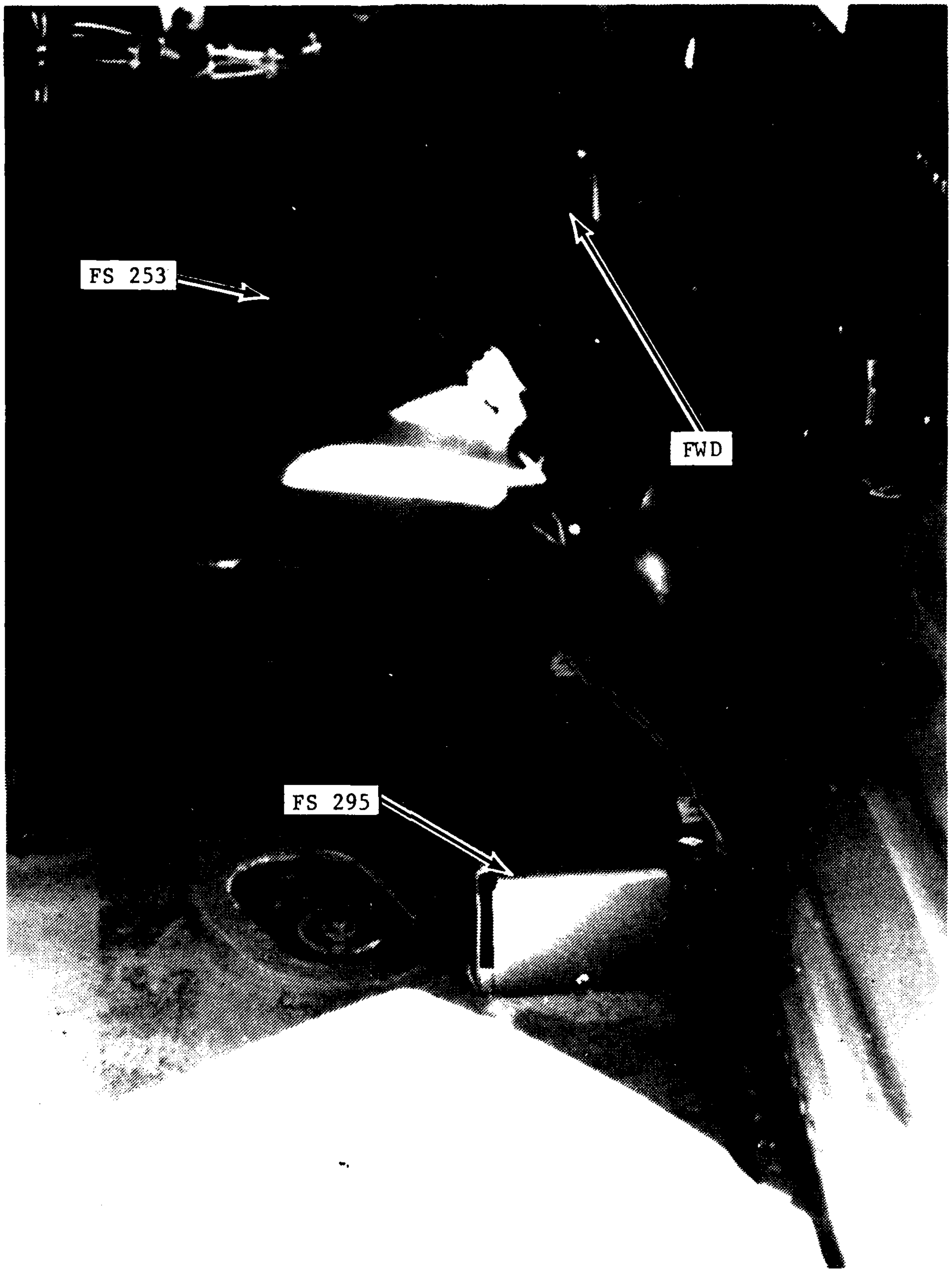


Figure C-3. Aircraft Cabin Floor Vibration Accelerometer
Location (Right Side)

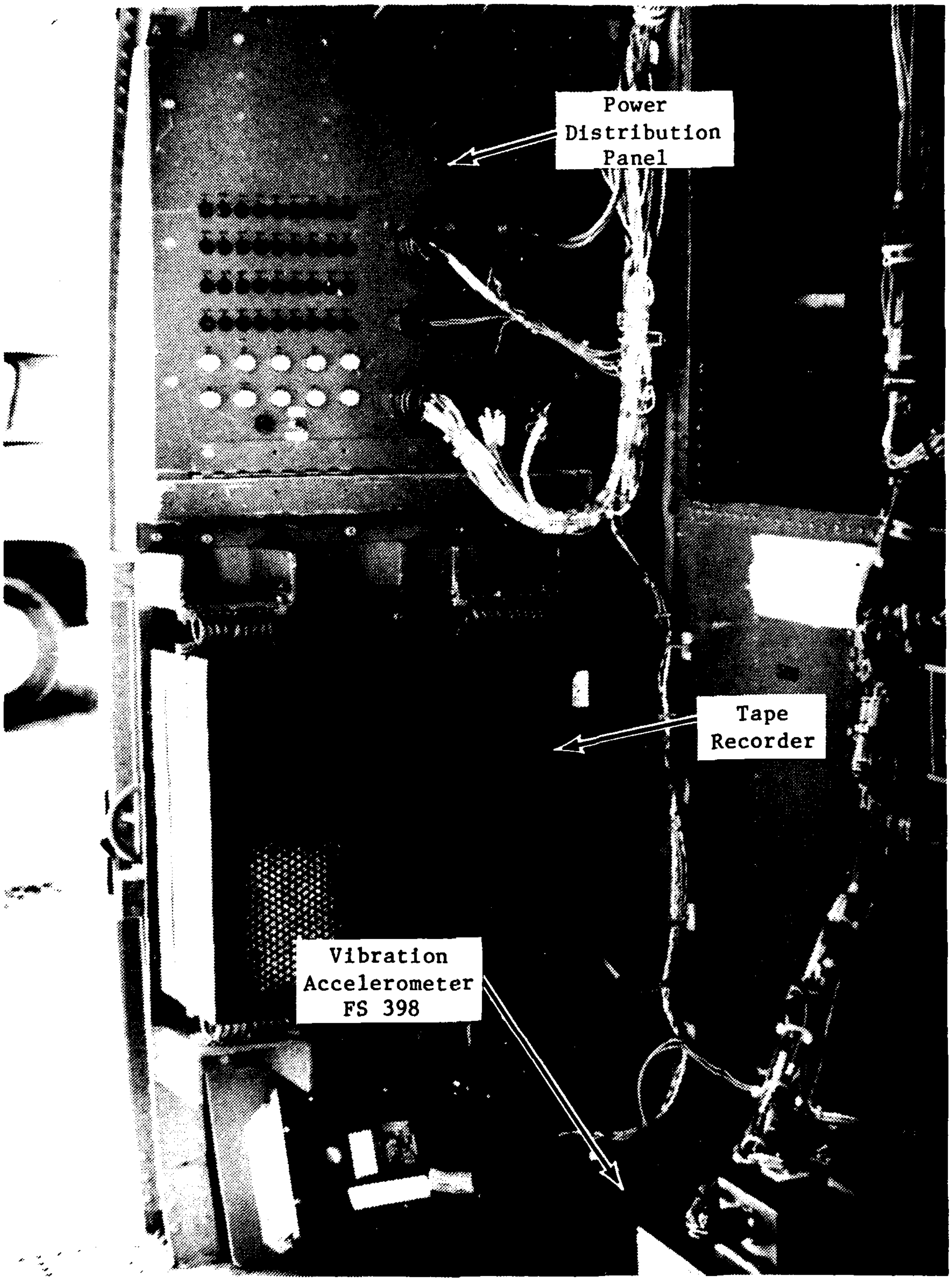


Figure C-4. Instrumentation Package (Aft Cabin - Right Side)

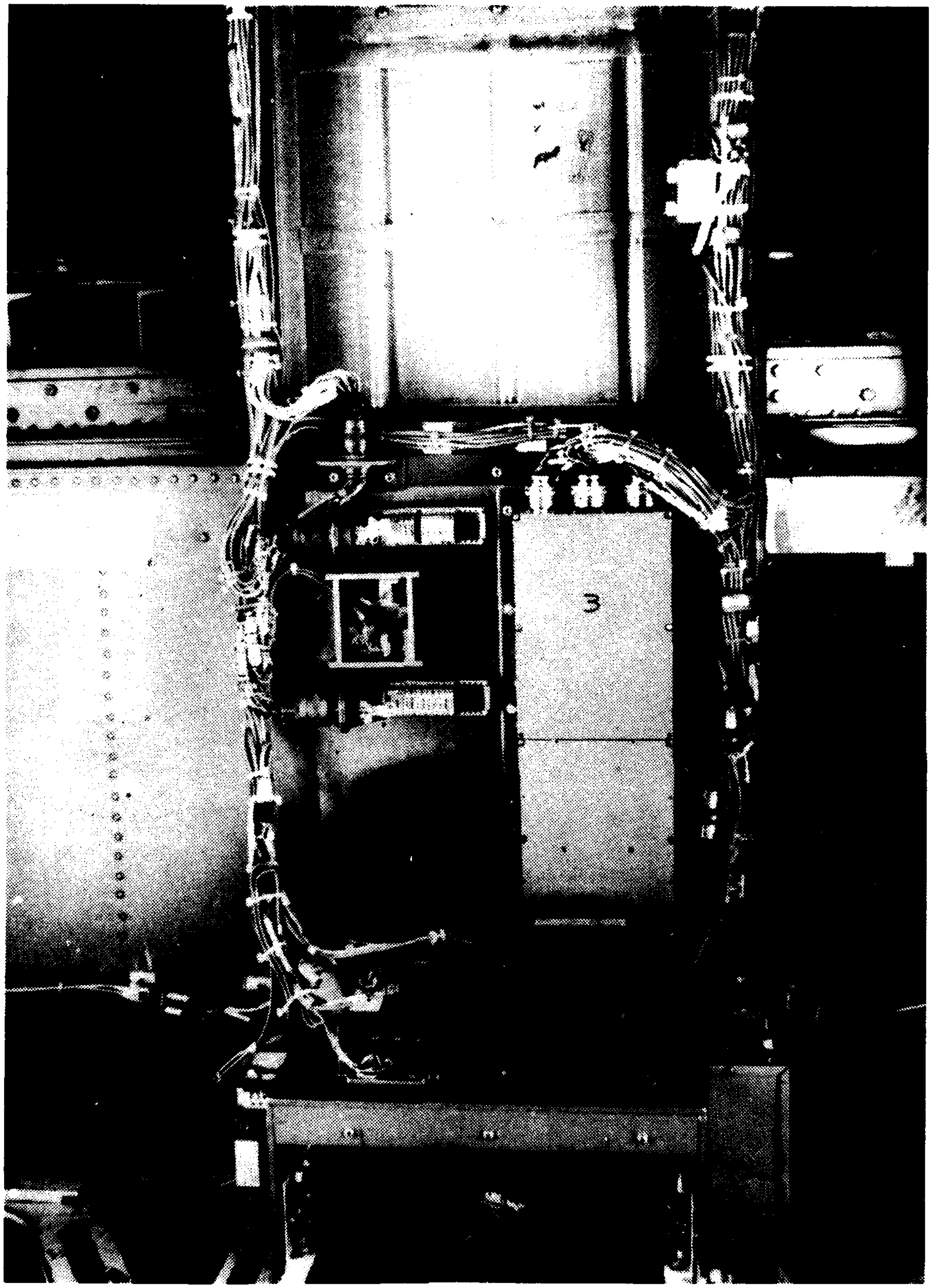


Figure C-5. Instrumentation Package (Aft Cabin - Center)

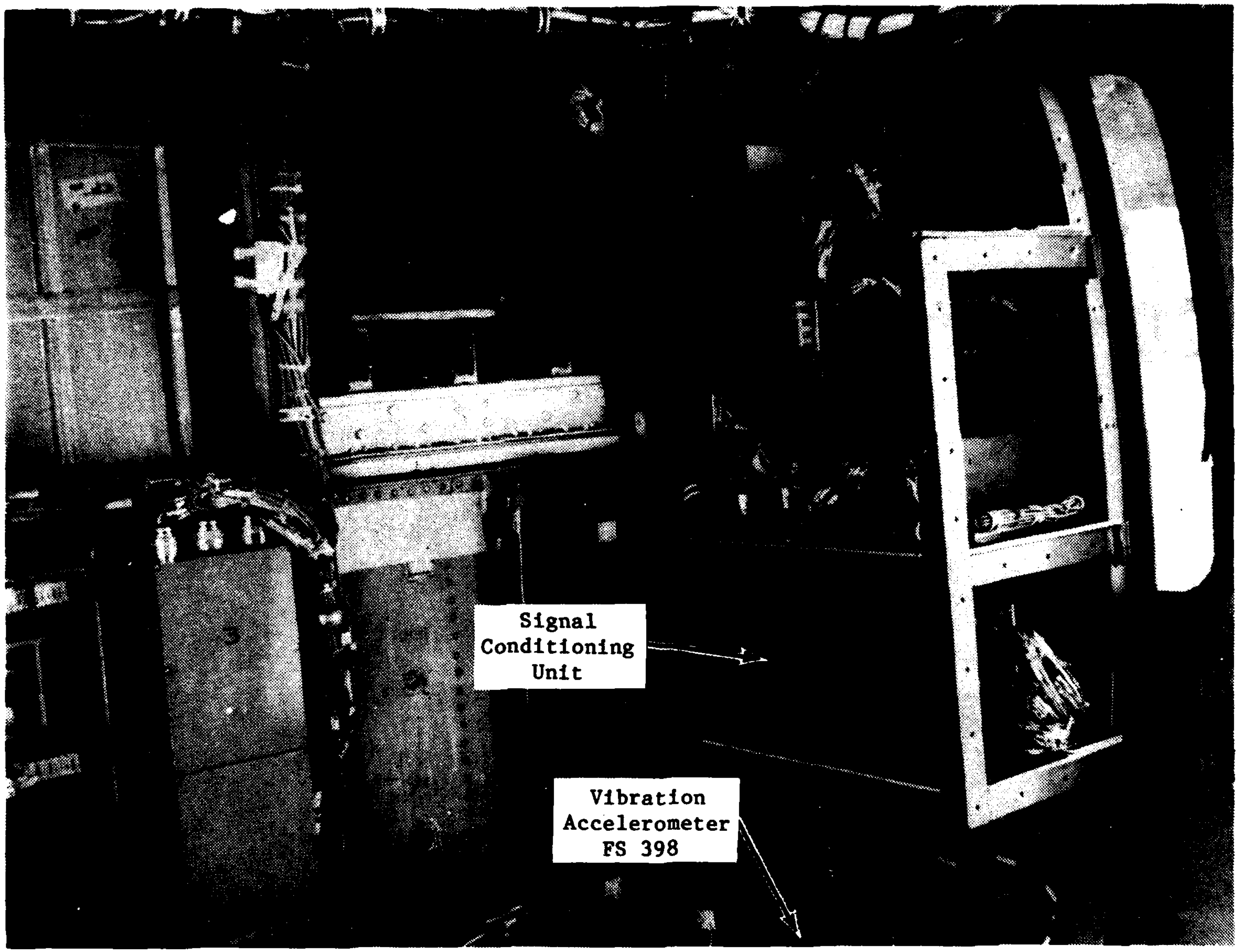


Figure C-6. Instrumentation Package (Aft Cabin - Left Side)

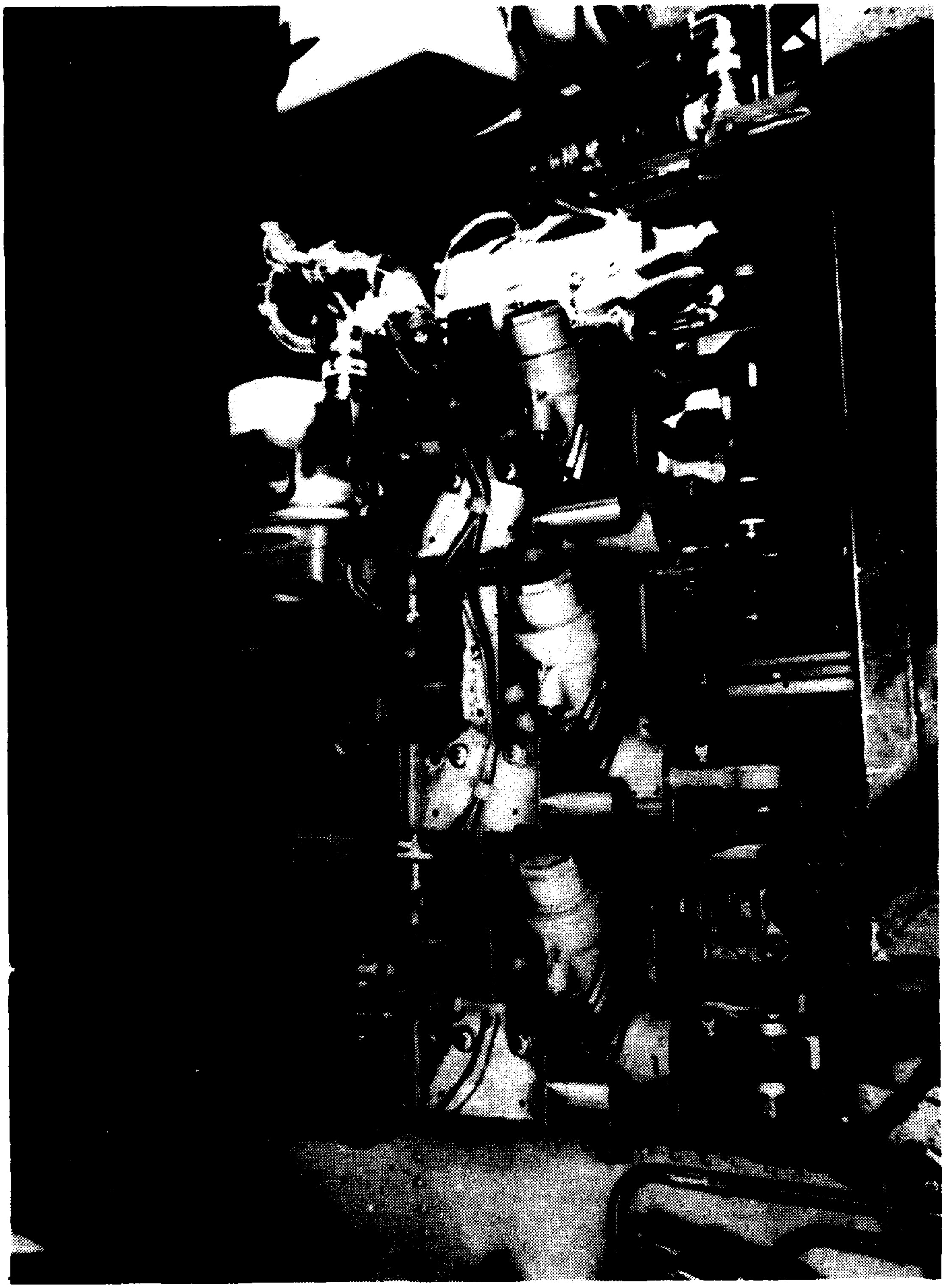


Figure C-7. Main Rotor Servoactuator and Mixer Position Instrumentation

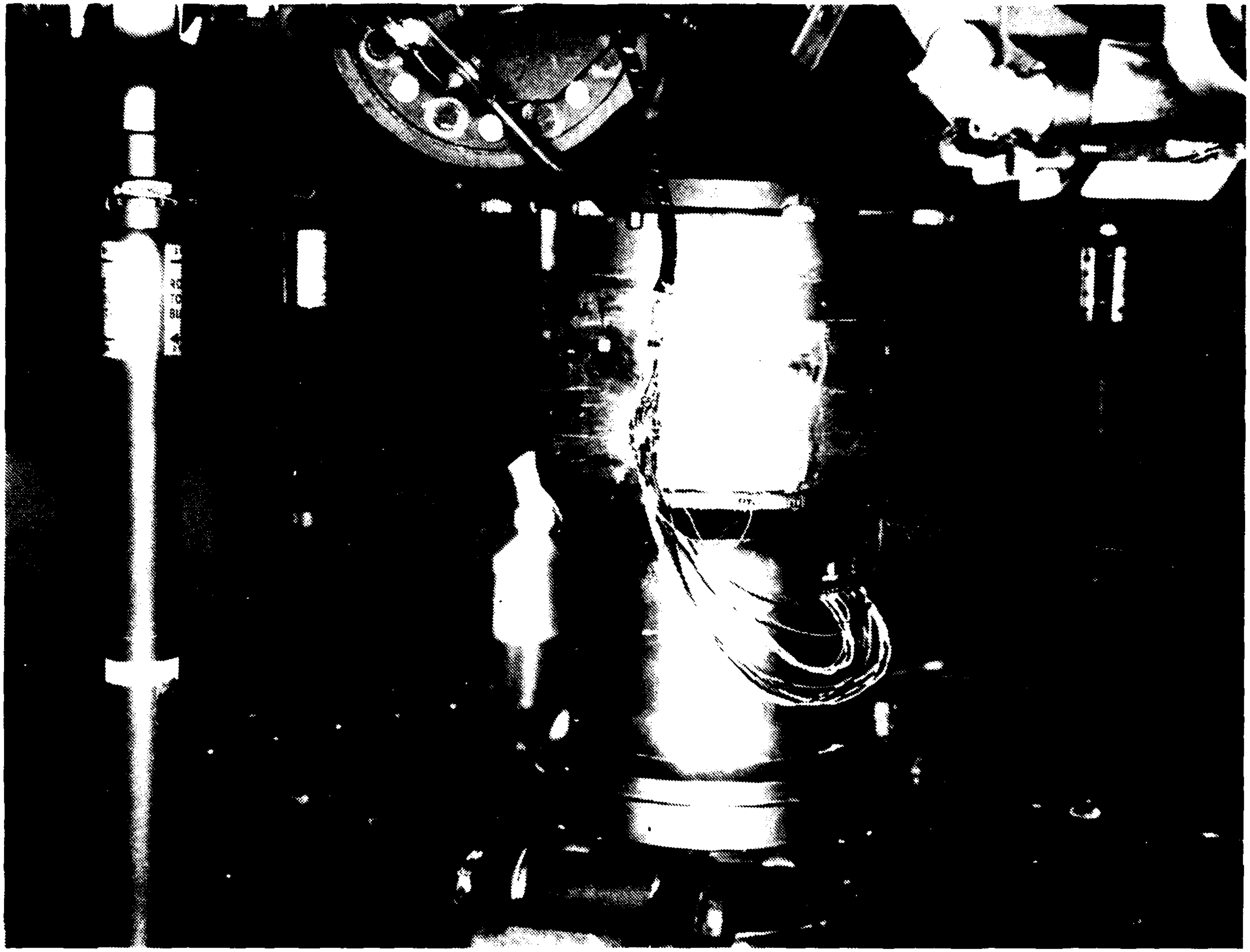


Figure C-8. Main Rotor Shaft Extension and Instrumentation

instrumented pitch change link. The accelerometers mounted on the main rotor hub are shown in figure C-9.

TEST BOOM AIRSPEED SYSTEM AND CALIBRATION

4. The test boom airspeed system extended forward of the nose of the test aircraft 67 inches and provided measurements of airspeed and altitude. Sensors for angles of attack and sideslip were also mounted on the test boom (fig. C-1). The tip of the swiveling pitot-static tube was located at fuselage station 97.0, 25.7 inches to the right of the aircraft centerline (buttline 25.7) and 7.0 inches below the forward avionics bay floor, waterline 208.0. The "bent up" shape provided ground clearance for takeoffs and ground handling.

5. The test boom airspeed system along with the standard ship's airspeed systems were calibrated in level and powered descent flight. A T-34 pace aircraft with two sperically installed and calibrated airspeed system was used to determine the test aircraft position error. Data obtained from a previous AEFA evaluation (ref 8, app A) using the same aircraft and boom airspeed system were used to corroborate test data. The position error of the boom airspeed system is presented in figure C-10. Altitude was corrected assuming the position error was completely from the static source.

ELLIOTT LOW AIRSPEED SENSING AND INDICATING EQUIPMENT

6. The Elliott Low Airspeed Sensing and Indicating Equipment (LASSIE), made by GEC Avionics, Rochester, Kent, England was used for the measurement of omnidirectional low airspeeds (below 22 knots true airspeed). The system consists of a swiveling probe mounted in the rotor downwash (fig. C-1), an onboard air data computer and an airspeed/directon indicator. The probe uses the rotor downwash to assure adequate dynamic pressure regardless of aircraft airspeed. At low airspeeds, the air data computer computes the airspeed relying primarily on probe angle. As aircraft speed increases, the computer computes airspeed based primarily on dynamic pressure much like a conventional pitot-static system. The transition from low to high speeds (20 knots true airspeed) is highly non-linear. Fluctuations on the airspeed indicator and output of the computer were as high as 10 knots at these airspeeds. A production LASSIE system installed and optimized for a specific type helicopter, such as the AH-1S, is normally programmed and through use of a weighing function based on dynamic pressure and probe angle reduces these fluctuations.

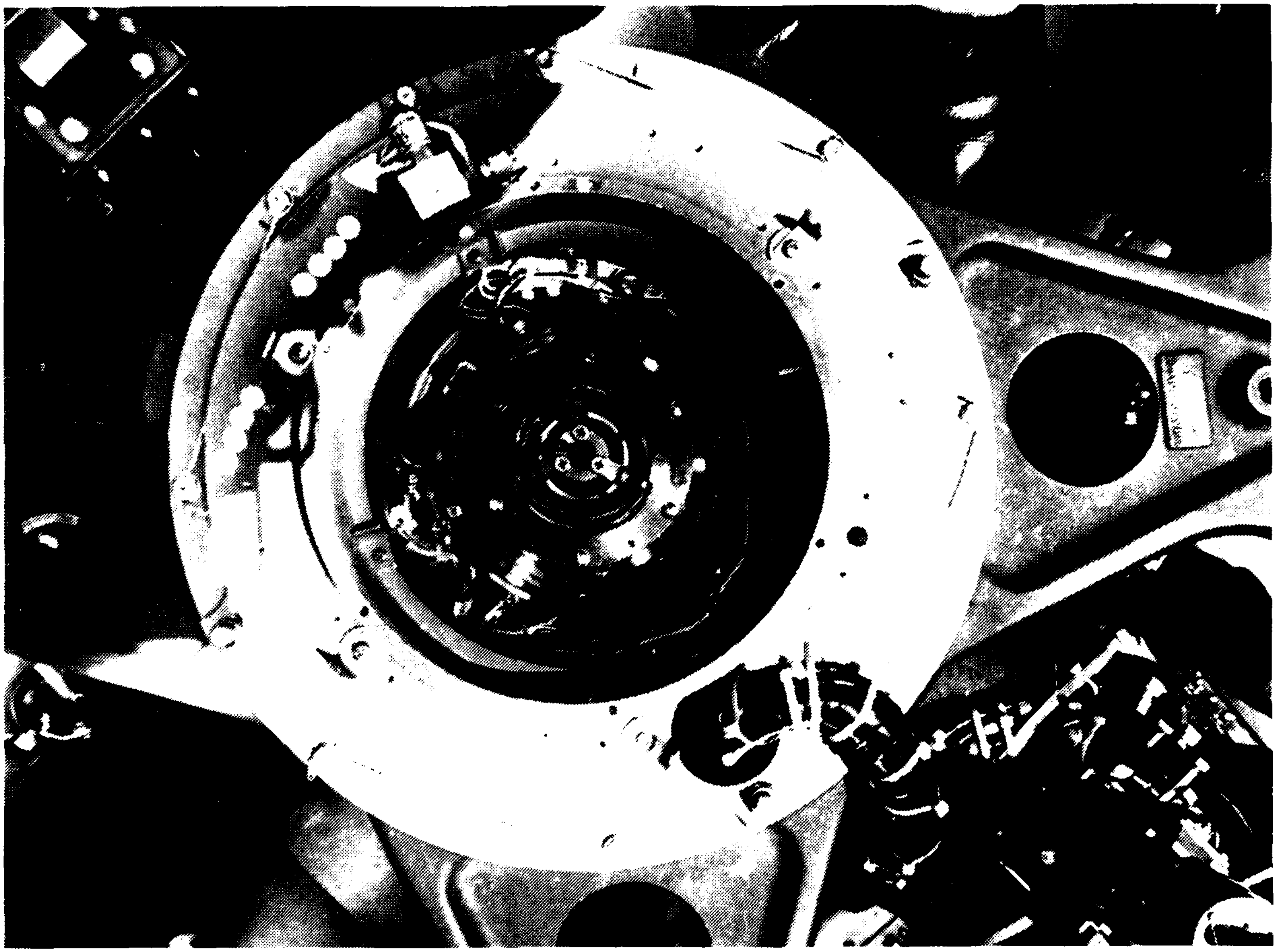
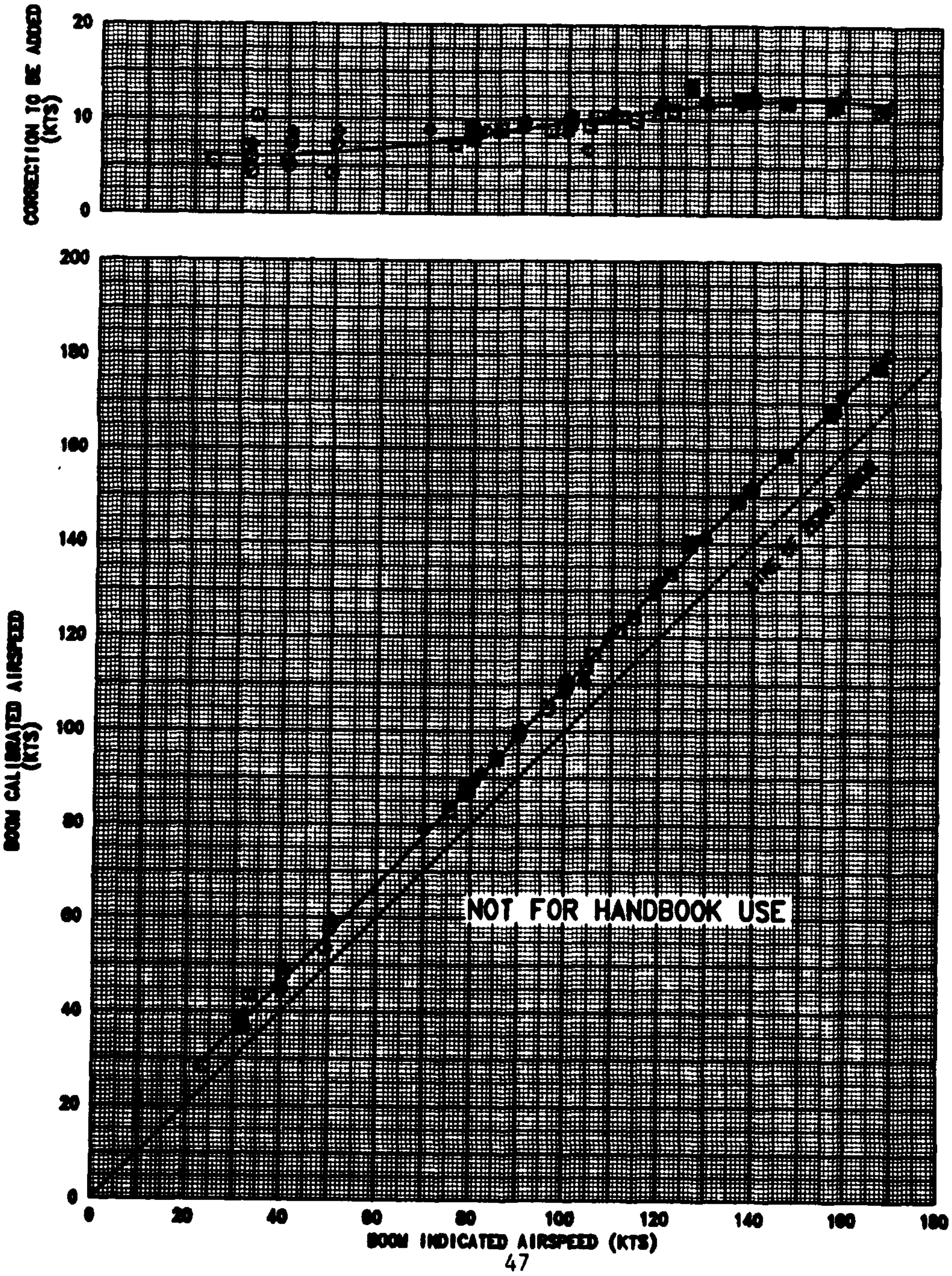


Figure C-9. Main Rotor Hub Accelerometer Installation
(Overhead View of Main Rotor Slip Ring)

FIGURE C-10
BOOM AIRSPEED CALIBRATION IN FORWARD FLIGHT
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT	TEST METHOD	DATA SOURCE AEFA REPORT NO.
□	15480	360.3 (AFT)	2070	10.0	258	0.005823	PACE AIRCRAFT	8801
○	16920	349.8 (MID)	6180	19.0	258	0.007202	GRND SPEED COURSE	—
△	16400	361.0 (AFT)	5100	7.0	257	0.006806	PACE AIRCRAFT	8423
◆	15720	347.6 (FWD)	2220	9.5	258	0.005939	PACE AIRCRAFT	8324
■	15490	360.3 (AFT)	5620	13.5	258	0.006482	PACE AIRCRAFT	—



The LASSIE system installed for this test program was not optimized for its location nor were airspeed signals modified. The probe gimbal was located at FS 249, BL 74 right, and WL 272.

7. The LASSIE system used for this program was calibrated out-of-ground effect using a ground speed course method. Calibrations for LASSIE longitudinal and lateral airspeed for both the data recorded on magnetic tape and from the cockpit indicator are presented in figures C-11 and C-12.

Engine Calibration

8. Each engine torque sensor system was specially calibrated in a test cell by the engine manufacturer, General Electric. Figures C-13 and C-14 present the calibrations used to determine engine output power.

MAIN ROTOR BLADE ANGLE MEASUREMENT

9. Three axes of blade motion (pitch, lead-lag and flapping) were measured on one main rotor blade. Three relative variable differential transducers (fig. C-15) were mounted on a fixture originally designed by Sikorsky Aircraft (SA) shown schematically in figure C-16 and provided to AEFA by NASA-Ames. Because each transducer is not located exactly along the axis of blade motion, a transformation, supplied by SA, was required to resolve measured angles into true blade angles. Coefficients for the transformation are determined empirically by positioning the main rotor blade at various combinations of pitch, flap and lead-lag angles and recording the output of the relative variable differential transducers. Several steps regarding the procedure to correct the measured blade angles to true blade angles were not defined, so only the measured blade angles are presented in this report.

Rotor Azimuth

10. Because blade angle measurements are only meaningful if a correlation can be made of blade location relative to the airframe, a main rotor azimuth measurement was necessary. The rotor azimuth system was designed to provide a continuous stream of parallel binary digital words proportional to instantaneous main rotor shaft position. The circuits do not measure azimuth directly, but process a square wave pulse train whose frequency is proportional to shaft speed, with a one per revolution pulse. Both the main and tail rotors were equipped with 1/rev signal generators that acted independently. Figure C-17 shows the relative position of the main and tail rotors at the instant the

FIGURE C-11
ELLIOT LOW AIRSPEED SYSTEM CALIBRATION
IN FORWARD AND REARWARD FLIGHT
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
15480	360.3 (AFT)	2070	10.0	258	0.005823

NOTE: GROUND SPEED COURSE METHOD USED WITH AIRCRAFT AT 100 FT WHEEL HEIGHT

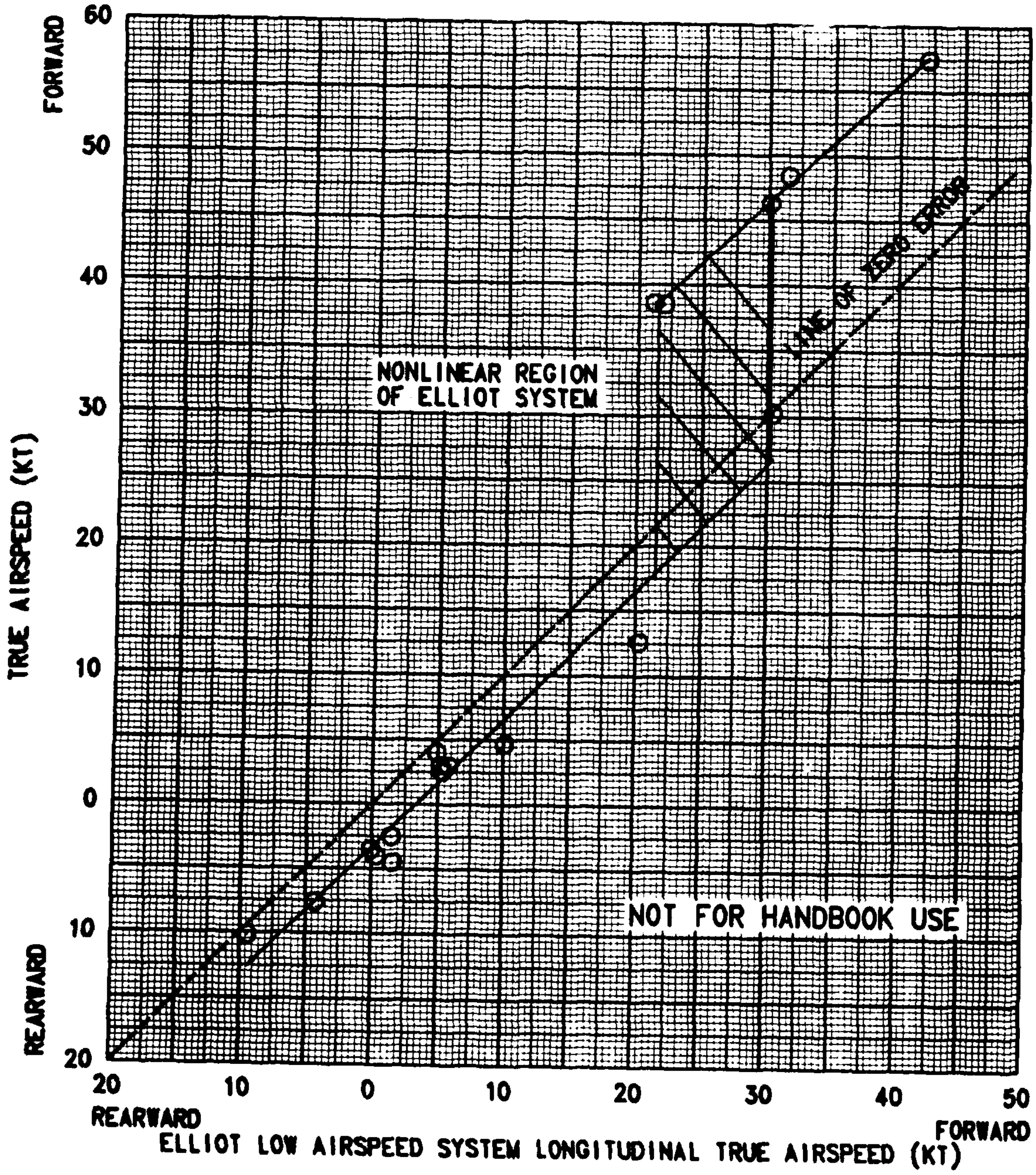


FIGURE C-12
ELLIOT LOW AIRSPEED SYSTEM CALIBRATION
IN SIDEWARD FLIGHT
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
15480	360.3 (AFT)	2070	10.0	258	0.005823

NOTE: GROUND SPEED COURSE METHOD USED
WITH AIRCRAFT AT 100 FT WHEEL HEIGHT

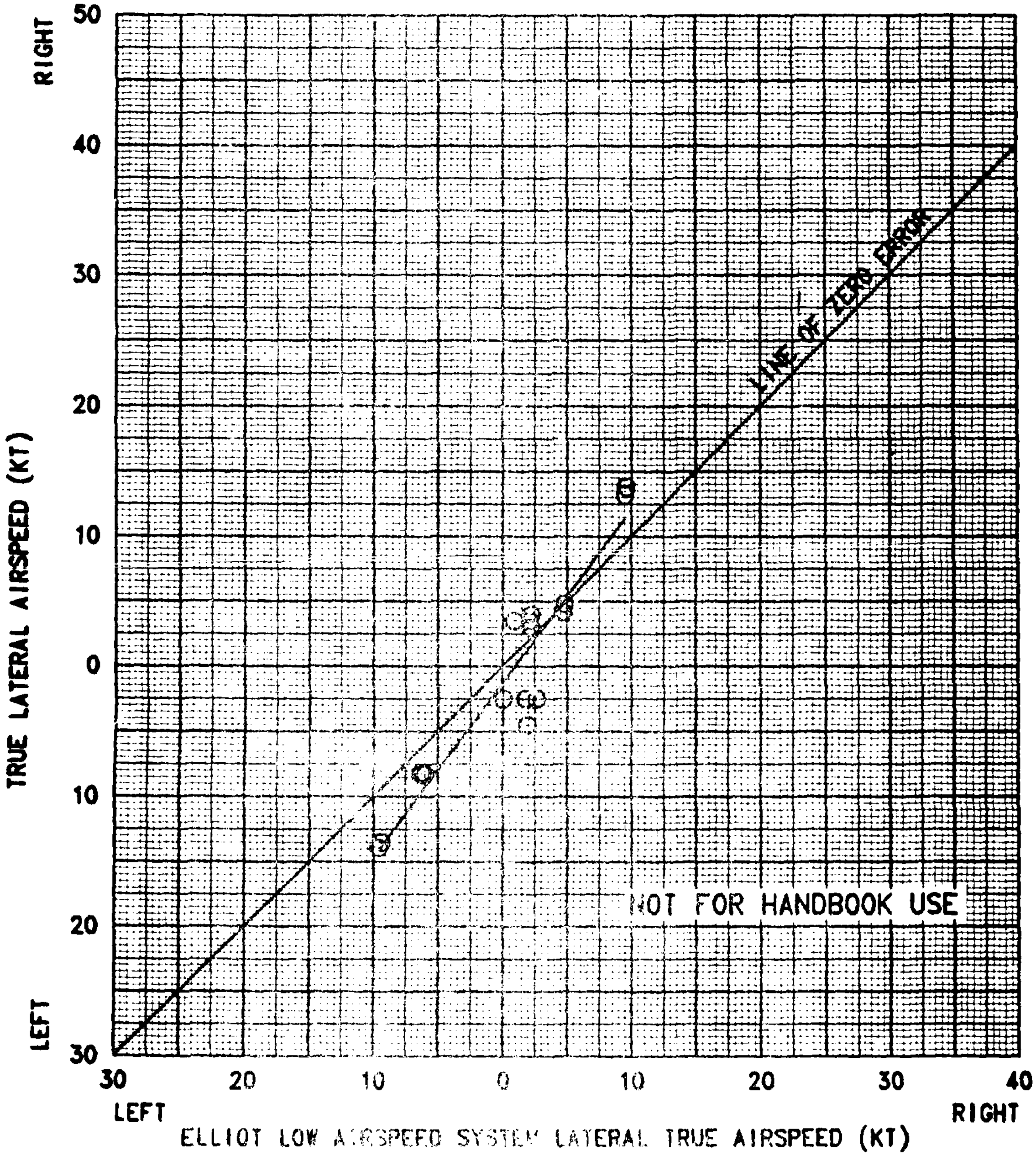


FIGURE C-13
ENGINE TORQUE SENSOR TEST CELL DATA
GE ENGINE MODEL T700-GE-700 S/N 306153

SYMBOL	POWER TURBINE SPEED (RPM)
⊙	19,862
⊡	20,896
Δ	21,078

NOTE: DATA OBTAINED FROM GENERAL ELECTRIC COMPANY ENGINE CALIBRATION TEST

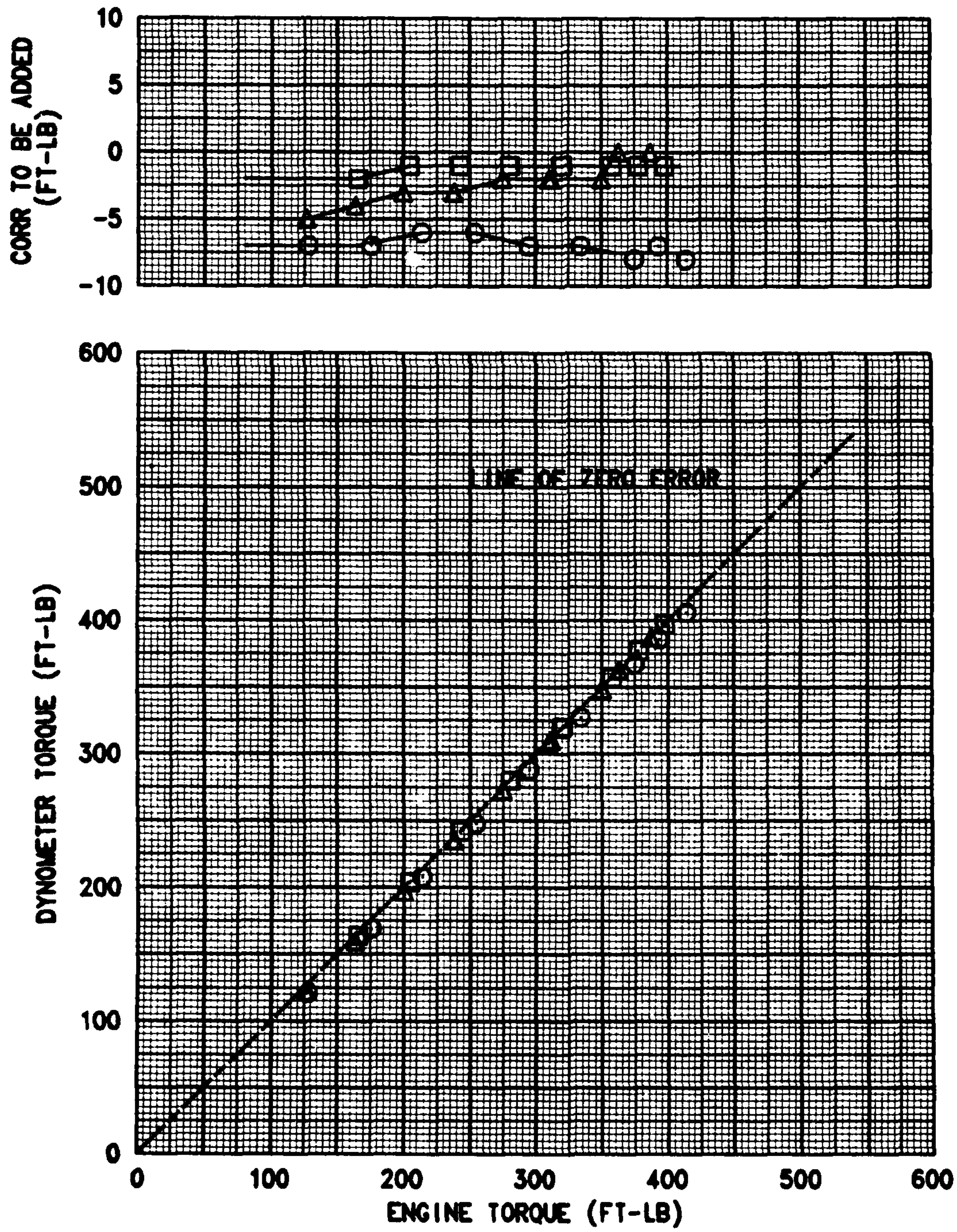
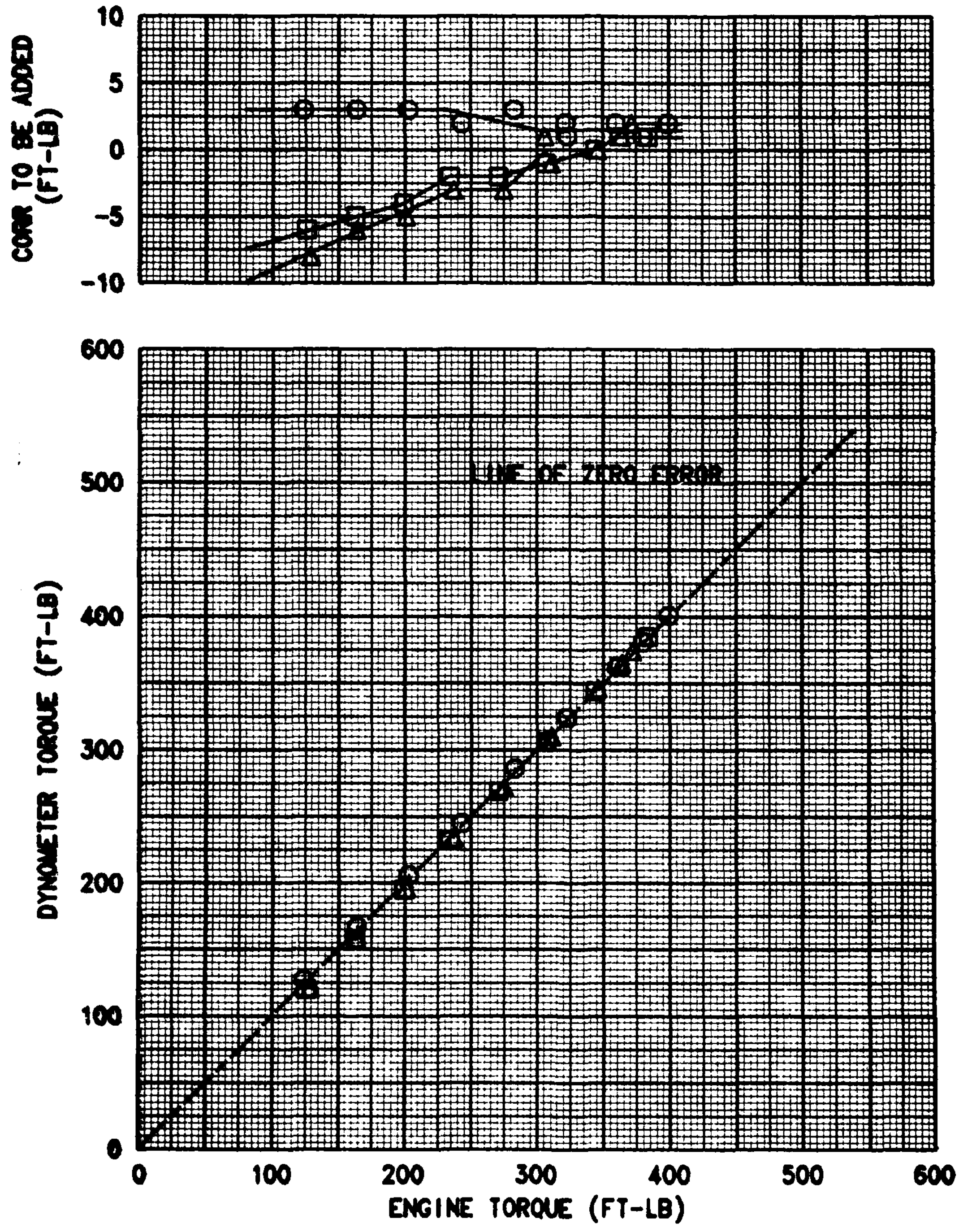


FIGURE C-14
ENGINE TORQUE SENSOR TEST CELL DATA
GE ENGINE MODEL T700-GE-700 S/N 207719

SYMBOL	POWER TURBINE SPEED (RPM)
⊙	19,855
⊡	20,892
△	21,057

NOTE: DATA OBTAINED FROM GENERAL ELECTRIC COMPANY ENGINE CALIBRATION TEST



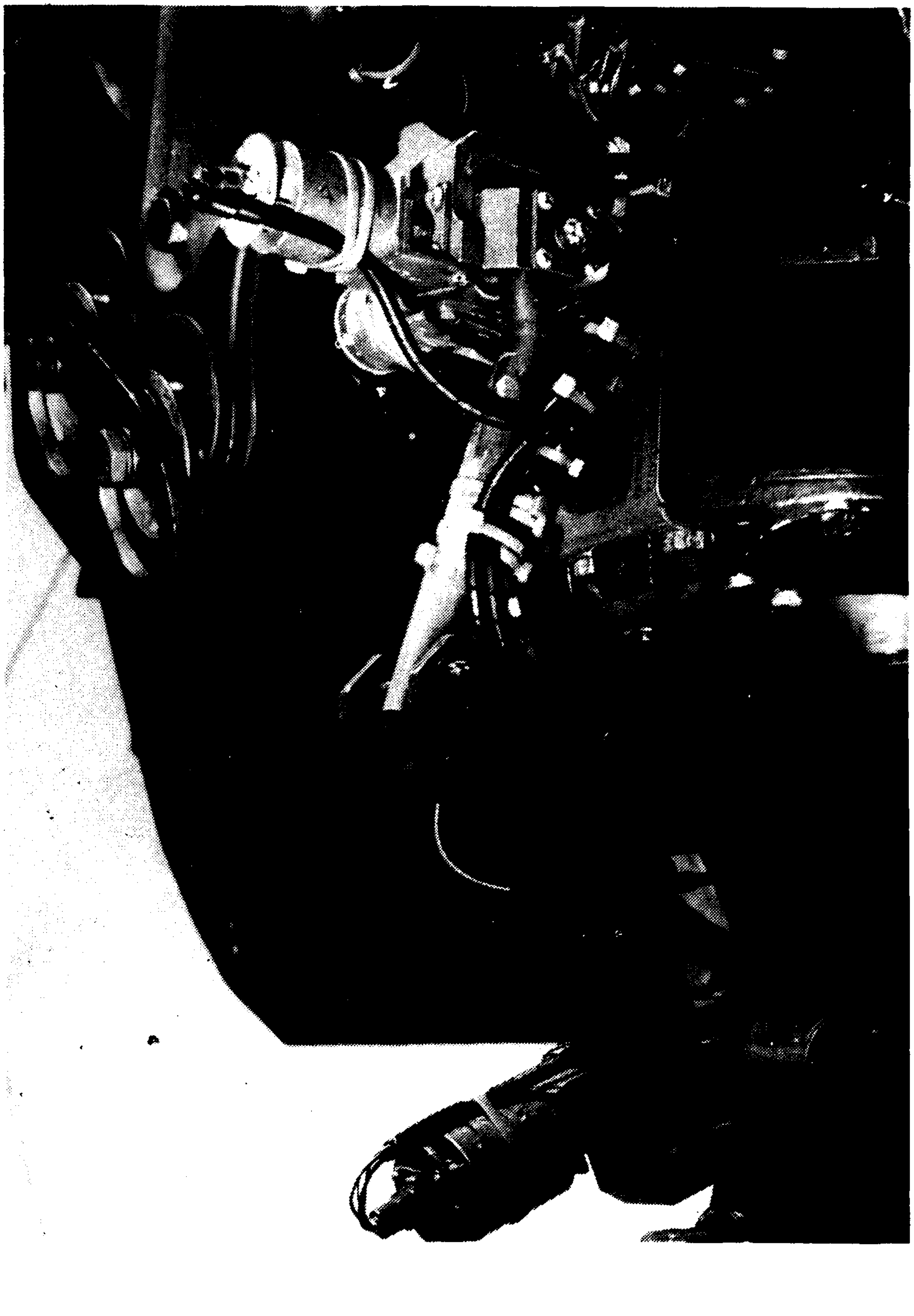


Figure C-15. Main Rotor Blade Position Measurement Equipment

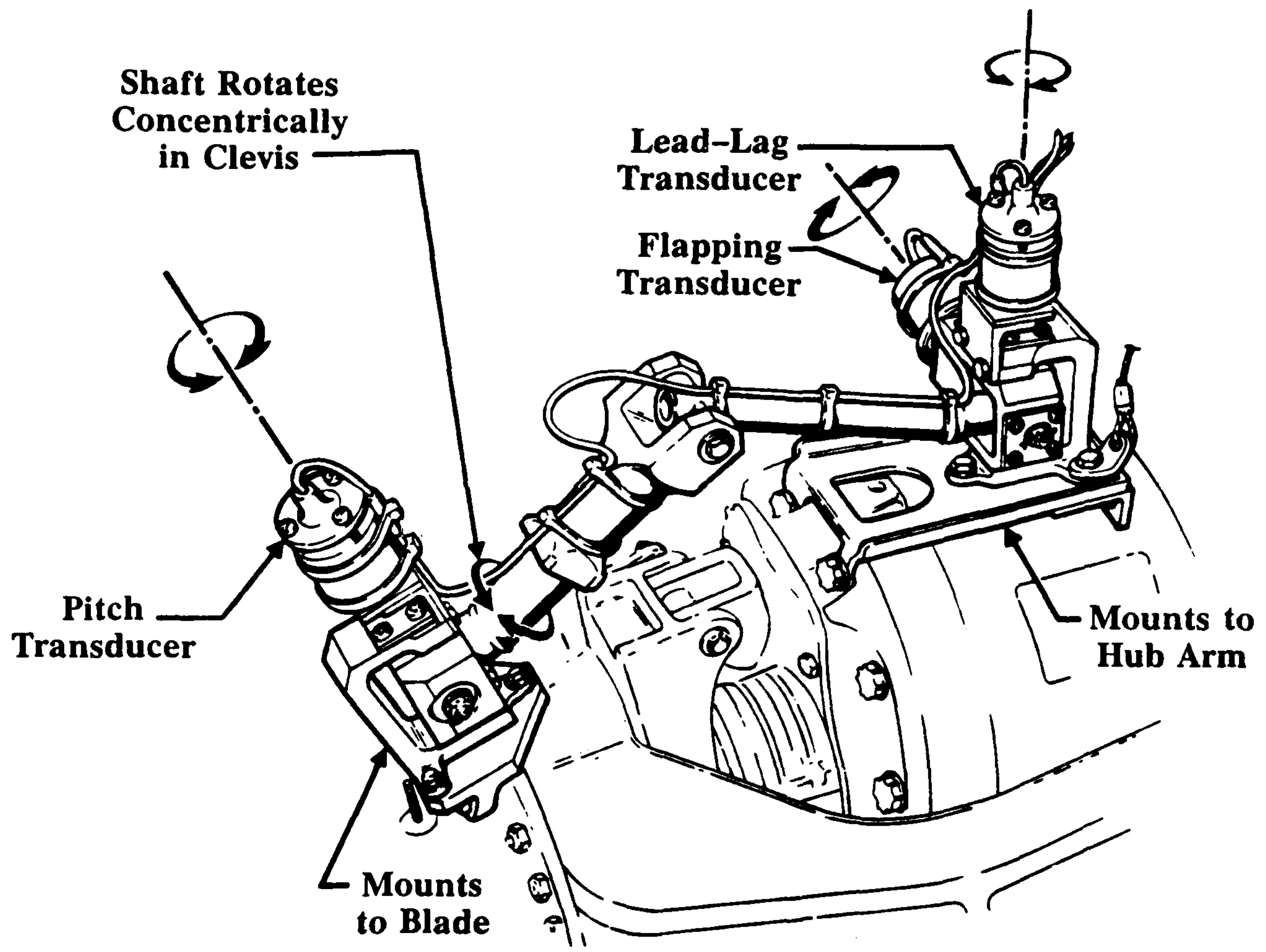
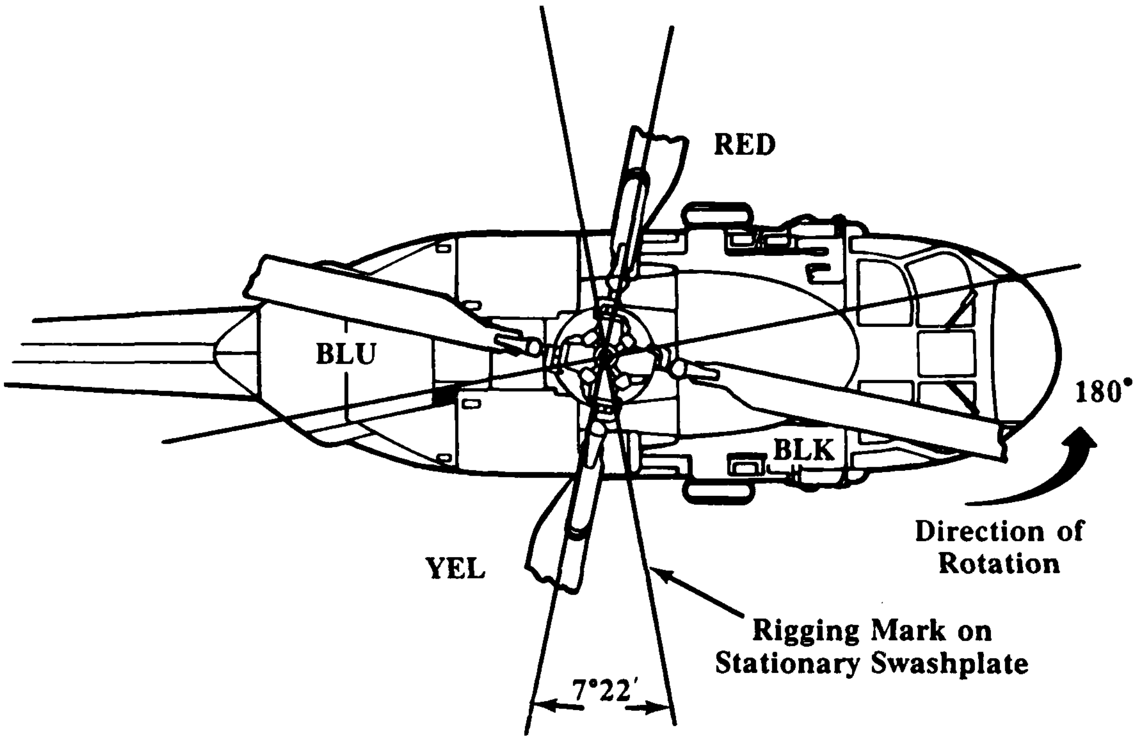
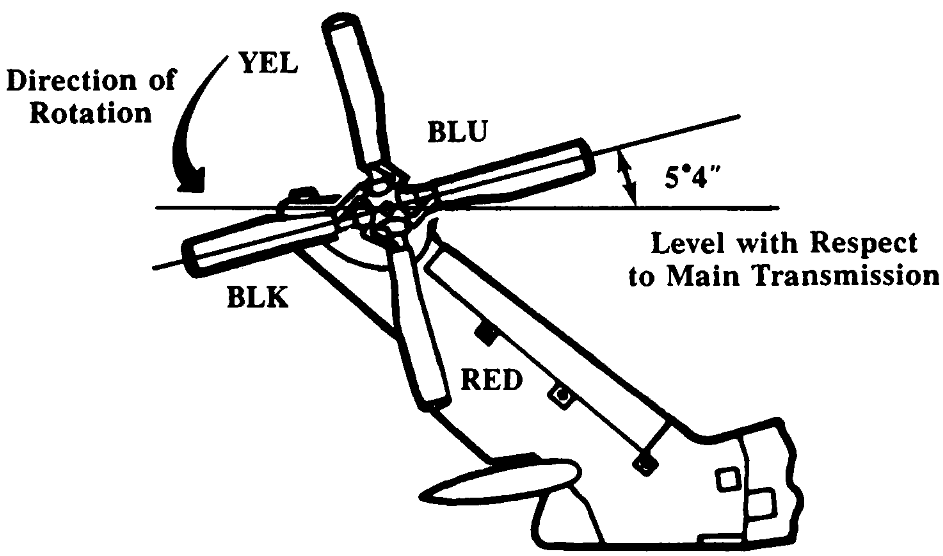


Figure C-16. Main Rotor Blade Angle Measurement



Main rotor 1/Rev pulse triggered when rigging mark on rotating swashplate for instrumented yellow blade is 7°22′ before the rigging mark on the main rotor stationary swashplate.



Tailrotor 1/Rev pulse triggered when blue blade is 5°4″ past the horizontal position with respect to the main transmission.

Figure C-17. Relative Position of Main and Tail Rotor When 1/Rev Signal Triggered

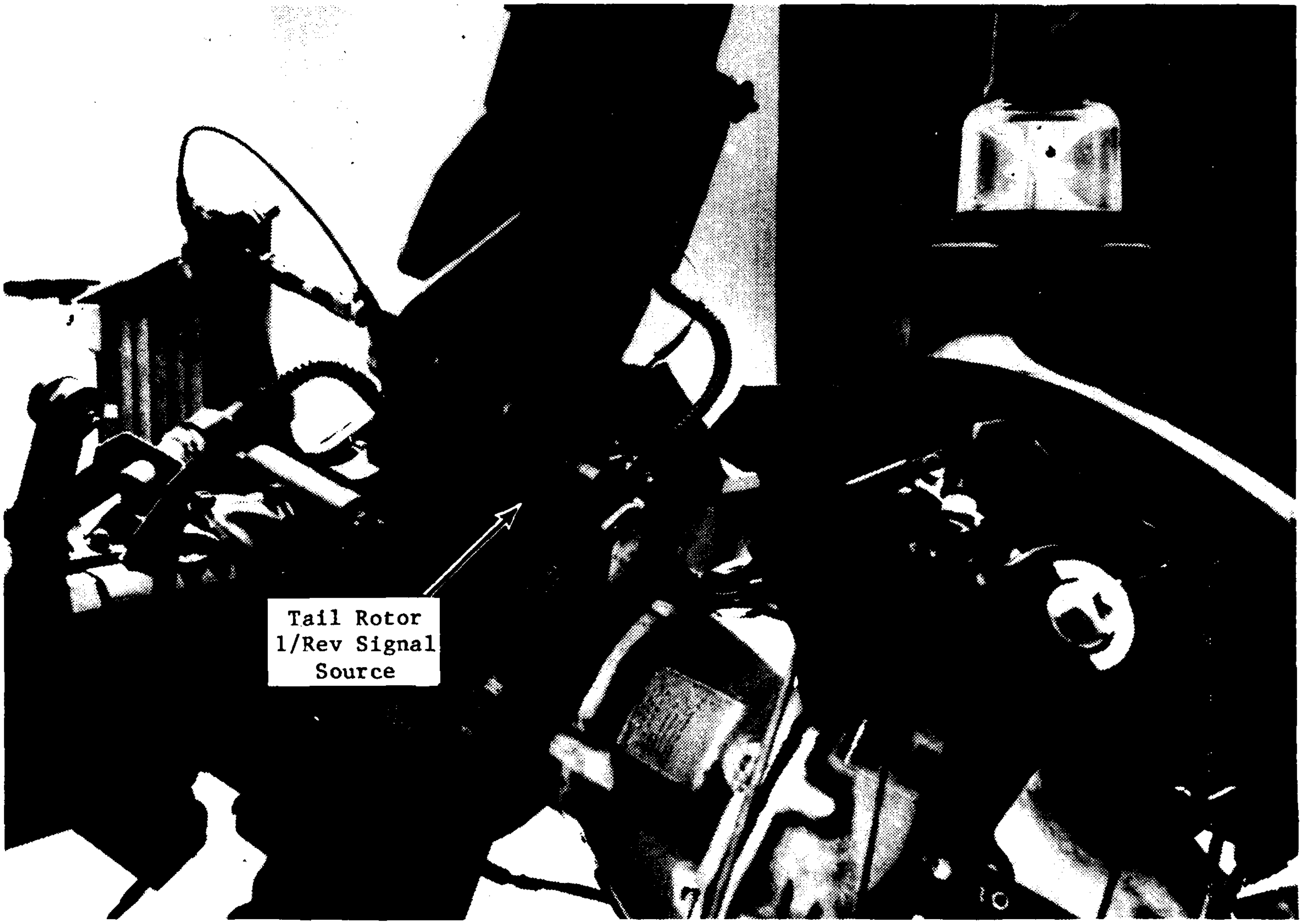


Figure C-18. Tail Rotor 1/Rev Signal Source

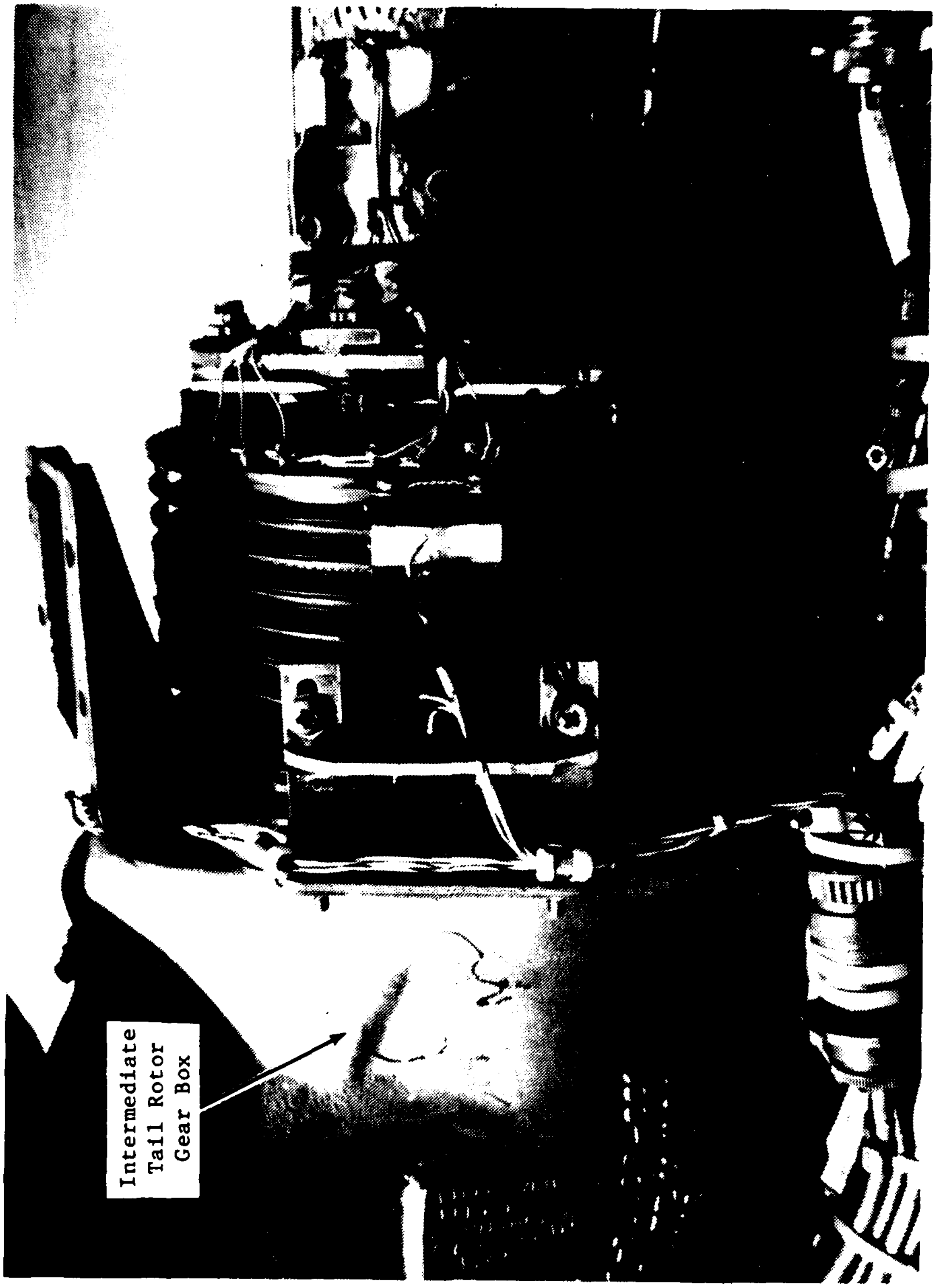


Figure C-19. Tail Rotor Driveshaft Slip Ring

pulse is sent. Figures C-18 and C-19 show the 1/rev signal generator for the tail rotor azimuth and the tail rotor slipring used to transmit the signal to the instrumentation package.

MAIN ROTOR BLADE ACCELEROMETERS

11. Two accelerometers were installed at the tip of the instrumented main rotor blade to measure normal and tangential acceleration. These accelerometers were attached to a mounting block that was bolted to the attachment point for the spanwise blade tip balance weights. Inside the main rotor blade tip cap. Another accelerometer was used to measure main rotor blade root normal acceleration and was installed on a block bolted to the main rotor spindle assembly.

APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

AIRCRAFT RIGGING

1. A flight controls engineering rigging check was performed on the main and tail rotors to insure compliance with established limits. The stabilator control system was checked for conformance with the production schedule with airspeed and collective control position. The rigging data are presented in table D-1 and figure D-2.

AIRCRAFT WEIGHT AND BALANCE

2. The aircraft was weighed in the instrumented configuration with all fuel drained and full oil prior to the start of the Black Hawk limits test program. The empty weight of the sixth year production aircraft was 11,673 pounds with the longitudinal center of gravity (cg) located at fuselage station (FS) 357.8 with the cg of the empty moveable ballast cart located at FS 301. The fuel cells and an external sight gage were also calibrated to determine partial fuel loads. The measured fuel capacity using the gravity fueling method was 364 gallons. The fuel weight for each test flight was determined prior to engine start and after engine shutdown by using the external sight gage to determine the volume and measuring the specific weight of the fuel. The calibrated cockpit fuel totalizer indicator was used during the test and at the end of each test compared with the sight gage readings. Aircraft cg was controlled in flight by a movable ballast system which was manually positioned to maintain a constant cg as fuel was burned. The movable ballast system (fig. D-3) consisted of a cart (2000-pound capacity) attached to the cabin floor by rails and driven by an electric screw jack with a total longitudinal travel of 72.3 inches. Lead weights secured inside the aircraft were used to adjust aircraft cg for test purposes.

AIRSPEED CALIBRATION

3. Two test airspeed systems were used to obtain aircraft speed during this evaluation. A nose mounted boom pitot-static airspeed system was used for airspeeds higher than 28 knots calibrated airspeed (KCAS) in forward flight. A low airspeed omnidirectional system described in appendix C was used for forward airspeeds below 28 KCAS and omnidirectional speeds below 10 knots. The low speed system was calibrated from 10 knots true airspeed (KTAS) rearward to 50 KTAS forward flight and left and right sideward flight to 10 KTAS using the ground speed course method. The aircraft was flown at a 100 foot wheel height (out-of-ground

Table D-1. Main and Tail Rotor Rigging Information

Main Rotor Rigging

Flight Control Position				Swashplate Tilt (Degrees)		Collective[1] Blade Pitch at the Root (degrees)
Collective	Longitudinal	Lateral	Pedal	Long	Lat	
Low	*[2]	*	*	-8.7	-2.1	9.6
High	*	*	*	-4.2	-3.3	24.3
Low	AFT	LT	*	-9.4	-7.4	8.8
High	AFT	LT	*	-9.2	-7.6	24.0
Low	FWD	RT	*	11.0	7.2	9.3
High	FWD	RT	*	17.3	6.5	23.4
High	AFT	LT	LT	-11.3	-7.7	23.6
Mid	AFT	LT	*	-11.7	-7.5	16.6
Mid	FWD	RT	*	15.6	6.2	15.5
Mid	*	*	*	-7.4	-2.6	17.0

Tail Rotor Rigging

Flight Control Position		Tail Rotor Collective Blade Pitch[1] at the Root (Degrees)
Collective	Pedal	
Mid	LT	-23.3
Mid	RT	7.5
Mid	MID	- 7.7
Low	MID	- 0.1
High	MID	-16.2
High	LT	-23.8
High	RT	- 1.8
Low	RT	6.3
Low	LT	-15.7

NOTES:

[1]Average of four blades.
[2]*Indicates appropriate control was pinned at a rigged position.

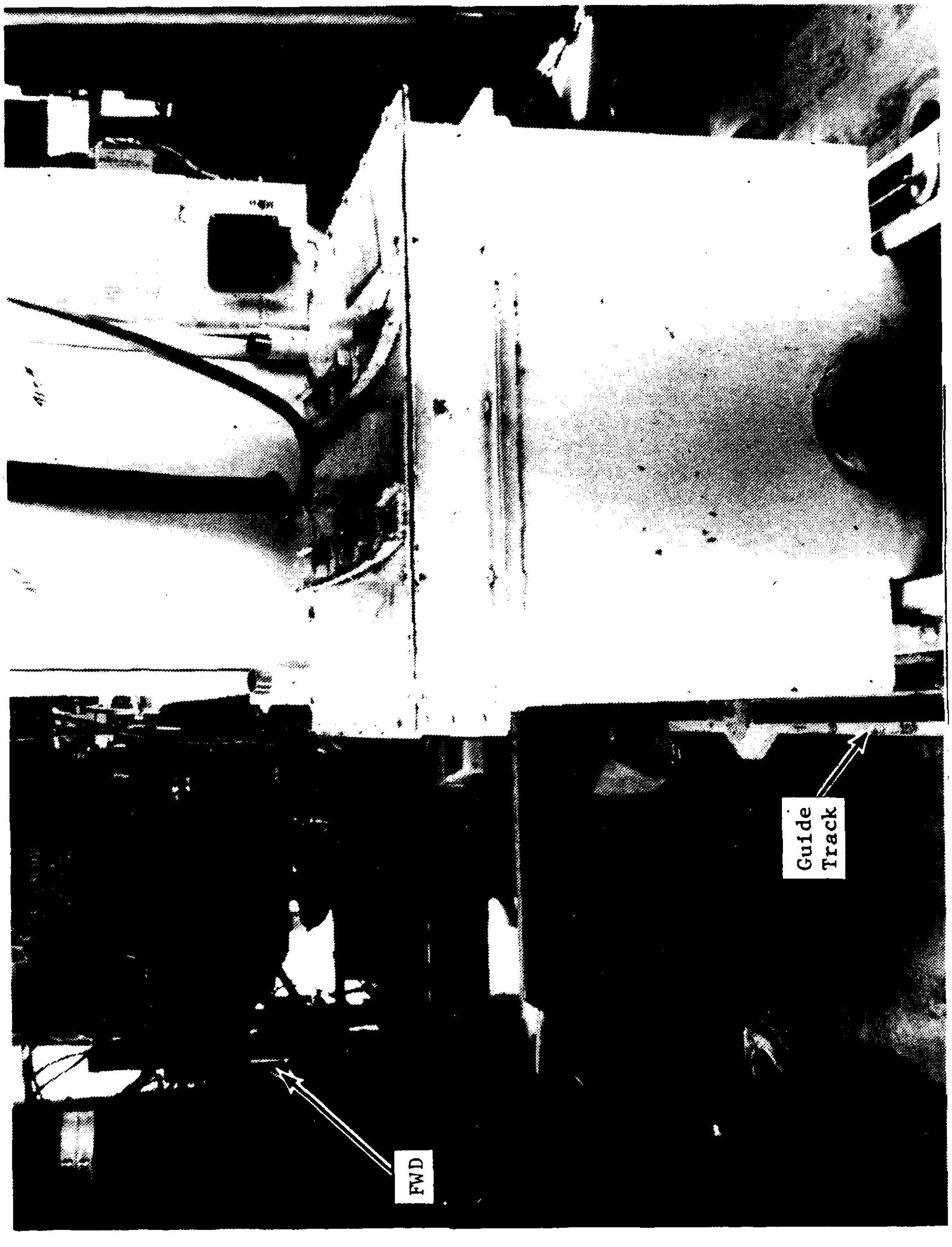


Figure D-3. Moveable Ballast Cart

effect) on reciprocal flight paths along a runway where markers were placed to establish the start and end of the course. The low speed system was first calibrated using light winds (2 to 5 knots) to establish zero airspeed forward, rearward, and sideward. The ground course was then flown using the low airspeed system maintaining zero lateral speed for forward and rearward airspeeds. Timing was accomplished by ground observers at the beginning and end of the course. Surface winds were 3 knots or less for this test. The results of the low-speed system calibration are shown in figures C-11 and C-12, appendix C. Above 22 KTAS in forward flight, the low-speed system appeared to be double valued, a speed indication of 22 knots could be either 19 or 39 KTAS. This region was at least highly nonlinear. Normally, a production system is optimized for a mounting position on the aircraft and a regression analysis using computed sideslip angle, probe angle, and dynamic pressure to provide a linear calibration for this type of low airspeed system. Since this optimization was not accomplished for the test system, airspeeds in the range from 15 to 25 KTAS were determined by observation of the angles of sideslip and attack, and dynamic pressure fluctuations. Above 25 KTAS, the boom airspeed system was used.

PERFORMANCE

General

4. Helicopter performance was generalized through the use of nondimensional coefficients as follows using the 1968 US Standard Atmosphere:

a. Coefficient of Power (C_P):

$$C_P = \frac{SHP\ (550)}{\rho A(\Omega R)^3} \qquad (1)$$

b. Coefficient of Thrust (C_T)/σ:

$$C_T/\sigma = \frac{GW}{\rho A(\Omega R)^2\ \sigma} \qquad (2)$$

c. $\mu = \left(\frac{V_T \ (1.6878)}{\Omega R} \right)$ (3)

Where:

SHP = Engine output shaft horsepower (total for both engines)

ρ = Ambient air density ($lb\text{-}sec^2/ft^4$) = $\rho_o \left(\frac{\delta}{\theta} \right)$

ρ_o = 0.0023769 ($lb\text{-}sec^2/ft^4$)

δ = Pressure ratio = $\frac{P_a}{P_{ao}}$

P_a = Ambient air pressure (in.-Hg)

P_{ao} = 29.92126 in.-Hg

θ = *Temperature* ratio = $\left(\frac{OAT + 273.15}{288.15} \right)$

OAT = Ambient air temperature (°C)

A = Main rotor disc area = 2262 ft^2

Ω = Main rotor angular velocity (radians/sec)

R = Main rotor radius = 26.833 ft

GW = Gross weight (lb)

σ = Main rotor blade area/disc area =

V_T = True airspeed (kt) = $\left(\frac{V_E}{1.6878\sqrt{\rho/\rho_o}} \right)$

1.6878 = Conversion factor (ft/sec-kt)

V_E = Equivalent airspeed (ft/sec) =

$$\left\{ \frac{7(70.7262\ P_a)}{\rho_o} \left(\left[\left(\frac{Q_c}{P_a} \right) +1 \right]^{2/7} -1 \right) \right\}^{1/2}$$

70.7262 = Conversion factor (lb/ft^2-in.-Hg)

Q_c = Dynamic pressure (in.-Hg)

At the normal operating rotor speed of 257.9 (100%), the following constants may be used to calculate C_P, C_T and μ:

ΩR = 724.685
$(\Omega R)^2$ = 525,168.152
$(\Omega R)^3$ = 380,581,411.4

5. The engine output shaft torque was determined by use of the engine torque sensor. The power turbine shaft twists as a function of applied torque. A concentric reference shaft is secured by a pin at the front end of the power turbine drive shaft and is free to rotate relative to the power turbine drive shaft at the rear end. The relative rotation is due to transmitted torque, and the resulting phase angle between the reference teeth on the two shafts is picked up by the torque sensor. The torque sensors for engines installed in the aircraft during this evaluation were specially calibrated in a test cell by the engine manufacturer, General Electric. The output from the engine sensor was recorded on the onboard data recording system. The output SHP was determined from the engine's output shaft torque and rotational speed by the following equation.

$$SHP = \frac{Q(N_P)}{5252.113} \qquad (4)$$

Where:

Q = Engine output shaft torque (ft-lb)

N_P = Engine output shaft rotational speed (rpm)

5252.113 = Conversion factor (ft-lb-rev/min-SHP)

The output SHP required was assumed to include 13 horsepower for daylight operations of the aircraft electrical system. A power

loss of 1.82 horsepower was used to corrected for the effects of electrical operation of the test instrumentation. Reductions in power required were made for the effect of external instrumentation drag except for the low speed omnidirectional airspeed system. This was determined by the following equation.

$$SHP_{instr\ drag} = \frac{\Delta F_e \ (\rho/\rho_o)(V_T)^3}{96254} \tag{5}$$

Where:

ΔF_e = 0.833 ft^2 (estimated)

96254 = Conversion factor (ft^2-kt^3/SHP)

The nominal fuel temperature of 55°C was used in the determination of engine fuel consumption.

Level Flight Performance

General:

6. Each speed power was flown in ball-centered flight by reference to a sensitive lateral accelerometer at a predetermined C_T/σ and referred rotor speed ($N_R/\sqrt{\theta}$). To maintain the ratio of gross weight to pressure ratio constant, altitude was increased as fuel was consumed. To maintain $N_R/\sqrt{\theta}$ constant, rotor speed was decreased as temperature decreased. Power corrections for rate-of-climb and acceleration were determined (when applicable) by the following equations.

$$SHP_{R/C} = -\frac{(R/C_{TL})(GW)}{33{,}000(K_p)} \tag{6}$$

$$SHP_{ACCEL} = -1.6098 \times 10^{-4} \left(\frac{\Delta V}{\Delta t}\right) (V_T)\ (GW) \tag{7}$$

Where:

R/C_{TL} = Tapeline rate of climb (ft/min) = $\left(\frac{\Delta H_P}{\Delta t}\right)\left[\frac{OAT + 273.15}{OAT_S + 273.15}\right]$

$$\left[\frac{\Delta H_P}{\Delta t}\right] = \text{Change in pressure altitude per unit time (ft/min)}$$

OAT_S = Standard ambient temperature at pressure altitude where $\frac{\Delta H_P}{\Delta t}$ was measured (°C)

K_P = power correction factor (0.76)

1.6098×10^{-4} = Conversion factor (SHP-sec/kt^2-lb)

$$\left[\frac{\Delta V}{\Delta t}\right] = \text{Change in airspeed per unit time (kt/sec)}$$

A power correction (when applicable) was used to insure ball-centered test data complied with the inherent sideslip family of curves depicting the UH-60A in the normal utility configuration. This correction was determined from ΔF_e as a function of sideslip angle (fig. 67, app E of ref 8, app A) and equation 5 rewritten as follows.

$$SHP_{s/s} = \frac{(\Delta F_{e\ in\ s/s} - \Delta F_{e\ B-C})\,(\rho/\rho_o)\,(V_T)^3}{96254} \qquad (8)$$

Where:

$\Delta F_e{}^*{}_{in\ s/s}$ = Change in equivalent flat plate area based on UH-60A inherent sideslip.

$\Delta F_e{}^*{}_{B-C}$ = Change in equivalent flat plate area based on the sideslip angle measured in ball-centered flight.

*Based on change in engine shaft horsepower.

Power required for level flight at the test day conditions was determined using the following equation.

$$SHP_t = SHP + SHP_{R/C} + SHP_{ACCEL} + SHP_{s/s} - SHP_{instr\ drag^{-1.82}} \qquad (9)$$

7. Test day level flight data was corrected to average test day conditions by the following equations.

$$SHP_s = SHP_t \frac{(\delta_s \sqrt{\theta_s}) \left[\frac{N_R}{\sqrt{\theta}} \right]^3_s}{(\delta_t \sqrt{\theta_t}) \left[\frac{N_R}{\sqrt{\theta}} \right]^3_t} \qquad (10)$$

$$V_{T_s} = V_{T_t} \frac{\left[\frac{N_R}{\sqrt{\theta}} \right]_s}{\left[\frac{N_R}{\sqrt{\theta}} \right]_t} \qquad (11)$$

Where:

N_R = Main rotor speed (rev/min)

subscript t = Test day

subscript s = Average test day

Test data corrected for rate of climb, acceleration, instrumentation installation, and corrected to inherent sideslip, standard altitude, and ambient temperature are presented in figures E-4 through E-6, appendix E.

8. Level flight performance was determined by using equations 1 through 3, rewritten in the following form.

$$C_P = \frac{SHP(478935.3)}{\sigma\sqrt{\theta} \left[\frac{N_R}{\sqrt{\theta}} \right]^3 \rho_o A R^3} \qquad (12)$$

$$C_T = \frac{GW(91.19)}{\delta \left[\frac{N_R}{\sqrt{\theta}}\right]^2 \rho_o A R^2} \quad (13)$$

$$\mu = \frac{V_T(16.12)}{R\sqrt{\theta} \left[\frac{N_R}{\sqrt{\theta}}\right]} \quad (14)$$

Where:

478935.3 = Conversion factor (ft-lb-sec^2-rev^3/min^3-SHP)

91.19 = Conversion factor (sec^2-rev^2/min^2)

16.12 = Conversion factor (ft-rev/min-kt)

9. Data analysis was accomplished by plotting C_P versus μ for each test at the average C_T. The curves through these data were then cross-faired as C_P versus C_T for lines of constant μ (figs. E-1 and E-4, app E). This carpet plot allows determination of power required as a function of airspeed and C_T.

10. The specific range (SR) data were derived from the test level flight power required and fuel flow (W_{F_t}). Selected level flight performance SHP and fuel flow data for each engine were referred as follows.

$$SHP_{REF} = \frac{SHP_t}{\delta\theta^{0.5}} \quad (15)$$

$$W_{F_{REF}} = \frac{W_{F_t}}{\delta\theta^{0.55}} \quad (16)$$

A curve fit was subsequently applied to the referred data and used as the basis to correct W_{F_t} to standard day fuel flow using the following equation.

$$W_{F_s} = W_{F_t} + \Delta W_F \quad (17)$$

Where:

ΔW_F = Change in fuel flow between SHP_t and SHP_s

The following equation was used for determination of specific range.

$$SR = \frac{V_{T_s}}{W_{F_s}} \quad (18)$$

Climb and Powered Descent Performance

11. The test technique was similar to level flight performance; however, since intermediate rated power was maintained approximately constant (fixed collective position) and airspeed varied above and below the maximum airspeed for level flight, altitude was gained or lost depending on the airspeed. The automatic flight control sytems were ON. Test data was obtained for a band of altitude equivalent to ± 1 percent of the aim C_T/σ (roughly ± 300 feet of altitude). Rotor speed was adjusted to that required for a referred rotor speed of 258 rpm at the initiation of each test point. The actual rotor speed was set based on the test day air temperature at the test altitude.

12. The test required a considerable amount of coordinated effort between the flight crew. The copilot adjusted rotor speed, set and maintained power and monitored altitude restrictions. The pilot flew the aircraft and monitored aircraft and engine limits. Once a test procedure was established by the flight crew, data was obtained quickly and easily. However, at airspeeds near the never exceed airspeed maximum continuous power was inadvertently not maintained because of the high flight crew workload. Tapeline rate of climb and descent data were calculated by the following equation:

$$R/C_{TL} = \left(\frac{\Delta H_P}{\Delta t}\right)\left[\frac{OAT + 273.15}{OATs + 273.15}\right] \quad (19)$$

Extrapolated level flight performance was calculated from tapeline rate of climb or descent by the use of equation 6.

HANDLING QUALITIES

Control Positions in Trimmed Forward Flight

13. Control positions and aircraft attitudes as functions of airspeed were measured during level flight climb and descent performance tests.

Maneuvering Flight Characteristics

14. This test was accomplished by establishing the trim condition and then incrementally increasing load factor by increasing roll attitude (in both directions) while holding airspeed and collective control position constant and allowing altitude to vary as necessary.

15. To establish bank angles at 45 degrees or greater, one of two techniques was used depending on trim airspeed. Both techniques required force trim and flight path stabilization turned off, otherwise the pilot constantly chased the artificial force system. At trim airspeeds below the maximum airspeed in level flight using intermediate rated power (V_H), the copilot was responsible for the collective control and aircraft and engine limits. This allowed the pilot to use both hands on the cyclic control and concentrate on pitch and roll attitude control as well as airspeed.

16. The techniques used for trim airspeeds at and above V_H established the trim airspeed at least 1000 feet above the aim altitude. This starting altitude increased proportionatly approximately 250 ft for each 10 knot increase in trim airspeed from V_H. Attaining the desired airspeed prior to rolling to the desired high bank angle was critical. Once at the desired airspeed, a small roll rate was used to establish the desired bank angle. The collective control was the copilot's responsibility. Additionally, because of the high work load, the copilot needed to verbally cue the pilot on angle of bank, airspeed, and trim. Turns to the left required slightly less work load than turns to the right.

Dynamic Stability

17. Flight control doublet inputs approximately 1.0 inch were used to investigate the aircraft response in each of the four

axes. The aircraft was trimmed in ball-centered flight then the doublet inputs were made using a control fixture. Both stability augmentation systems were turned off for these tests.

APPENDIX E. TEST DATA

FIGURE E-1
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748
REFERRED ROTOR SPEED = 258.1 RPM

NOTES: 1. BALL CENTERED TRIM CONDITION EXCEPT FOR AIRSPEEDS BELOW 30 KNOTS, WHERE ZERO LATERAL SPEED WAS USED
2. AVERAGE LONGITUDINAL CENTER OF GRAVITY LOCATION AT FS 360.8
3. DATA DERIVED FROM FIGURES 5 THROUGH 7

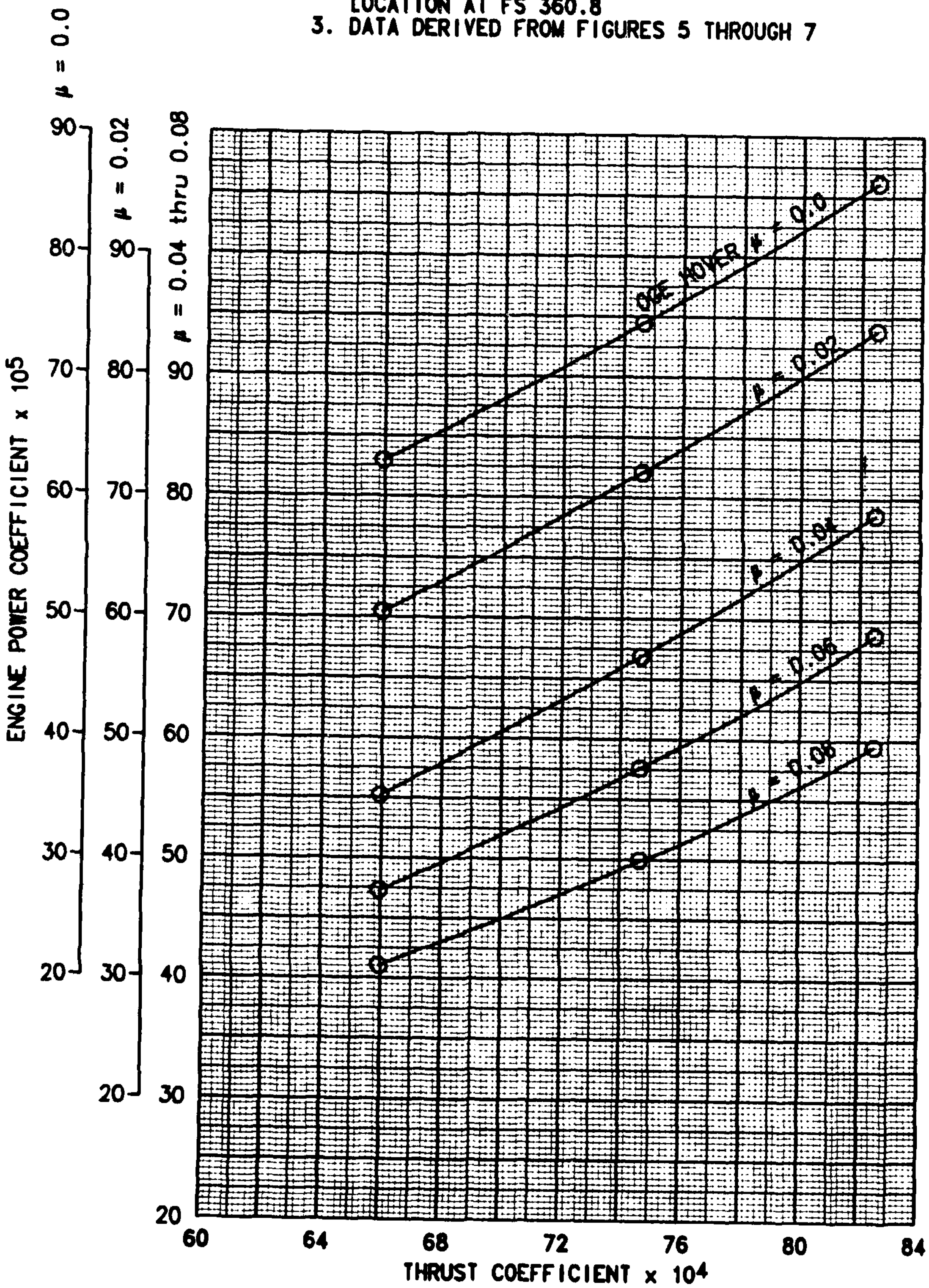


FIGURE E-2
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748
REFERRED ROTOR SPEED = 258.1 RPM

NOTES: 1. BALL CENTERED TRIM CONDITION EXCEPT FOR AIRSPEEDS BELOW 30 KNOTS, WHERE ZERO LATERAL SPEED WAS USED
2. AVERAGE LONGITUDINAL CENTER OF GRAVITY LOCATION AT FS 360.8
3. DATA DERIVED FROM FIGURES 5 THROUGH 7

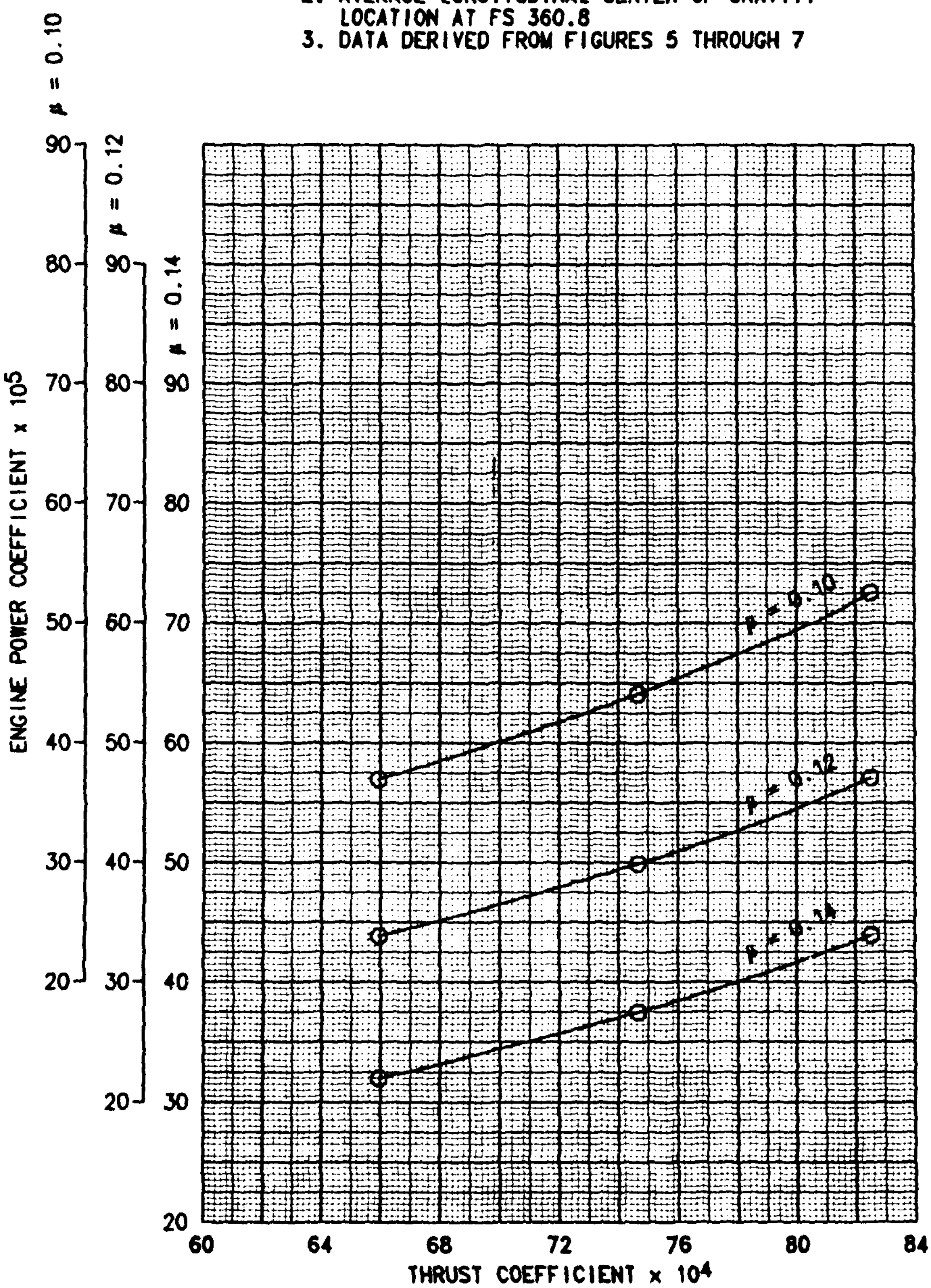


FIGURE E-3
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748
REFERRED ROTOR SPEED = 258.1 RPM

NOTES: 1. BALL CENTERED TRIM CONDITION EXCEPT FOR AIRSPEEDS BELOW 30 KNOTS, WHERE ZERO LATERAL SPEED WAS USED
2. AVERAGE LONGITUDINAL CENTER OF GRAVITY LOCATION AT FS 360.8
3. DATA DERIVED FROM FIGURES 5 THROUGH 7

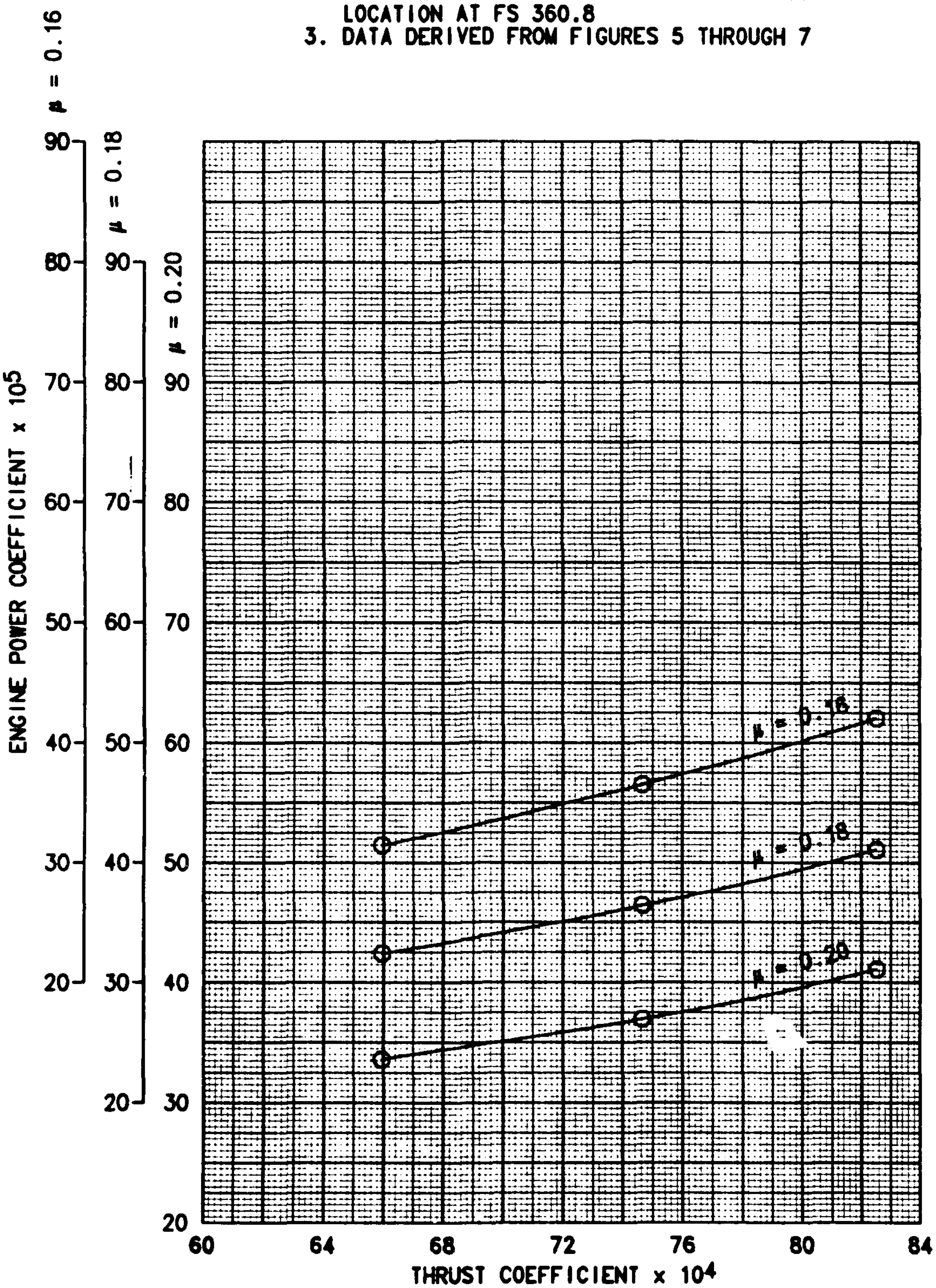


FIGURE E-4
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-60A USA S/N 82-23748
REFERRED ROTOR SPEED = 258.1 RPM

NOTES:
1. BALL CENTERED TRIM CONDITION EXCEPT FOR AIRSPEEDS BELOW 30 KNOTS, WHERE ZERO LATERAL SPEED WAS USED
2. AVERAGE LONGITUDINAL CENTER OF GRAVITY LOCATION AT FS 360.8
3. DATA DERIVED FROM FIGURES 5 THROUGH 7

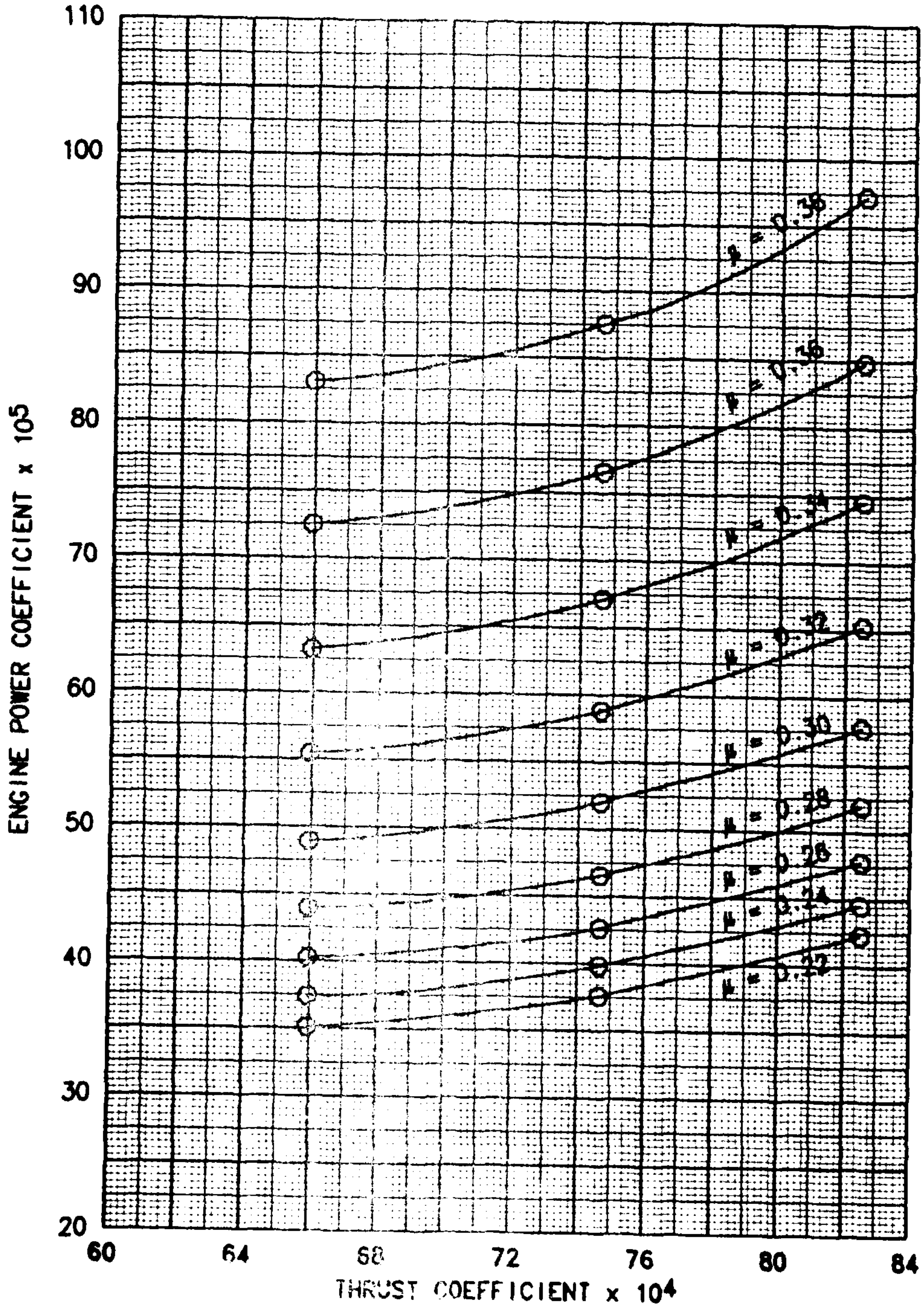


FIGURE E-5

LEVEL FLIGHT PERFORMANCE

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
15560	361.0(AFT)	5750	12.5	258.0	0.006595

NOTE: BALL-CENTERED TRIM

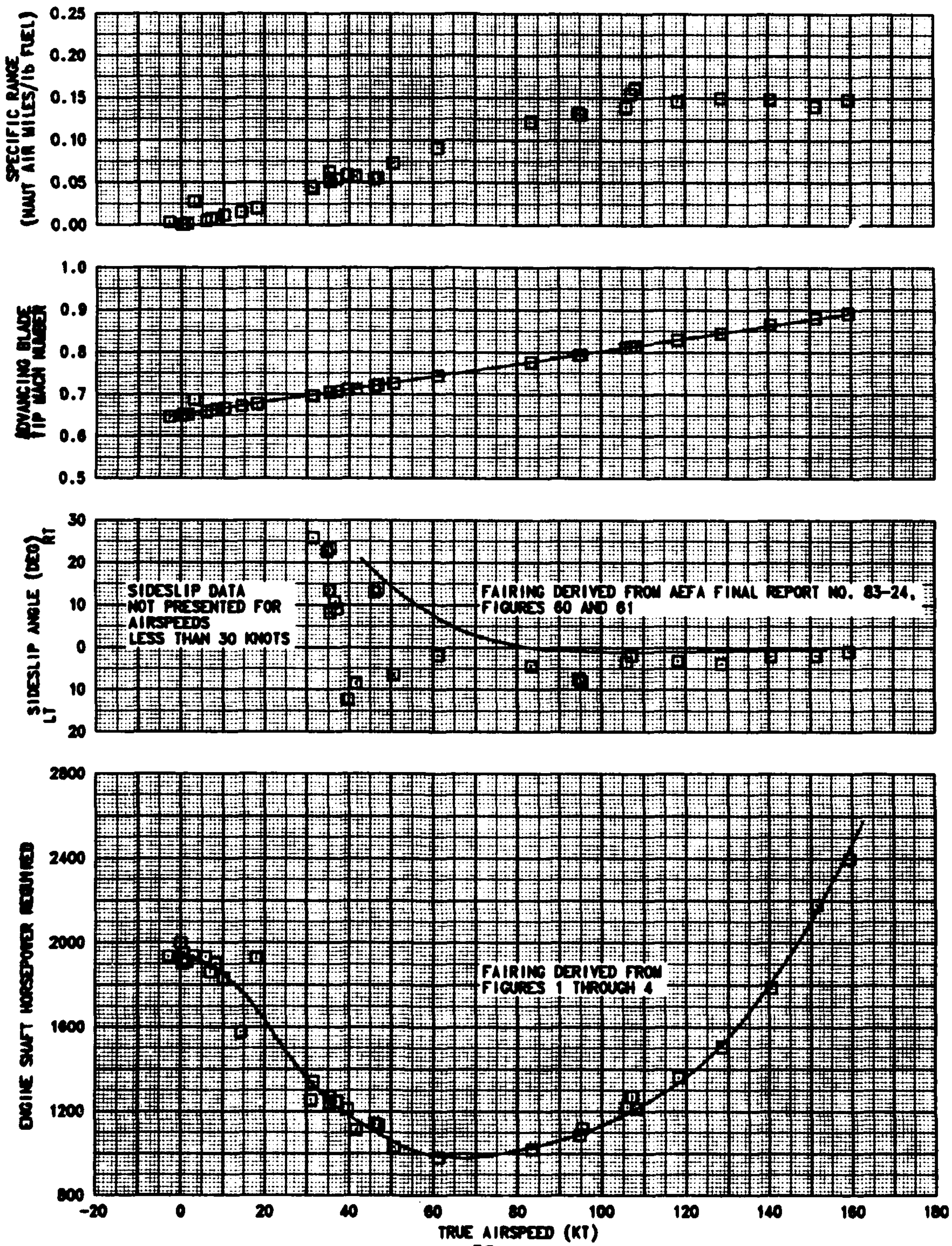


FIGURE E-6

LEVEL FLIGHT PERFORMANCE

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
17080	360.8(AFT)	6930	14.0	258.0	0.007465

NOTE: BALL-CENTERED TRIM

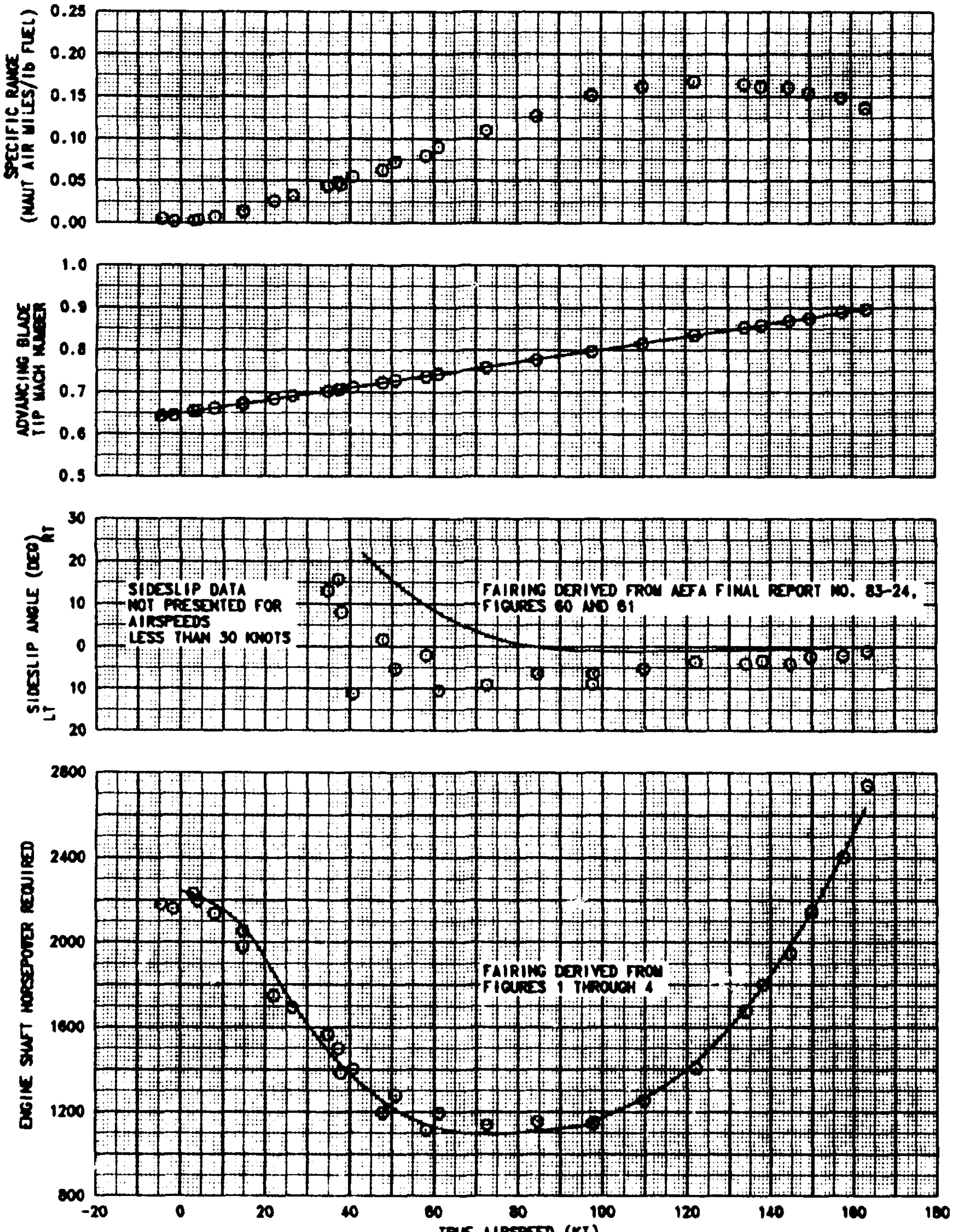


FIGURE E-7

LEVEL FLIGHT PERFORMANCE

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
19040	360.5(AFT)	6900	15.5	258.3	0.008252

NOTE: BALL-CENTERED TRIM

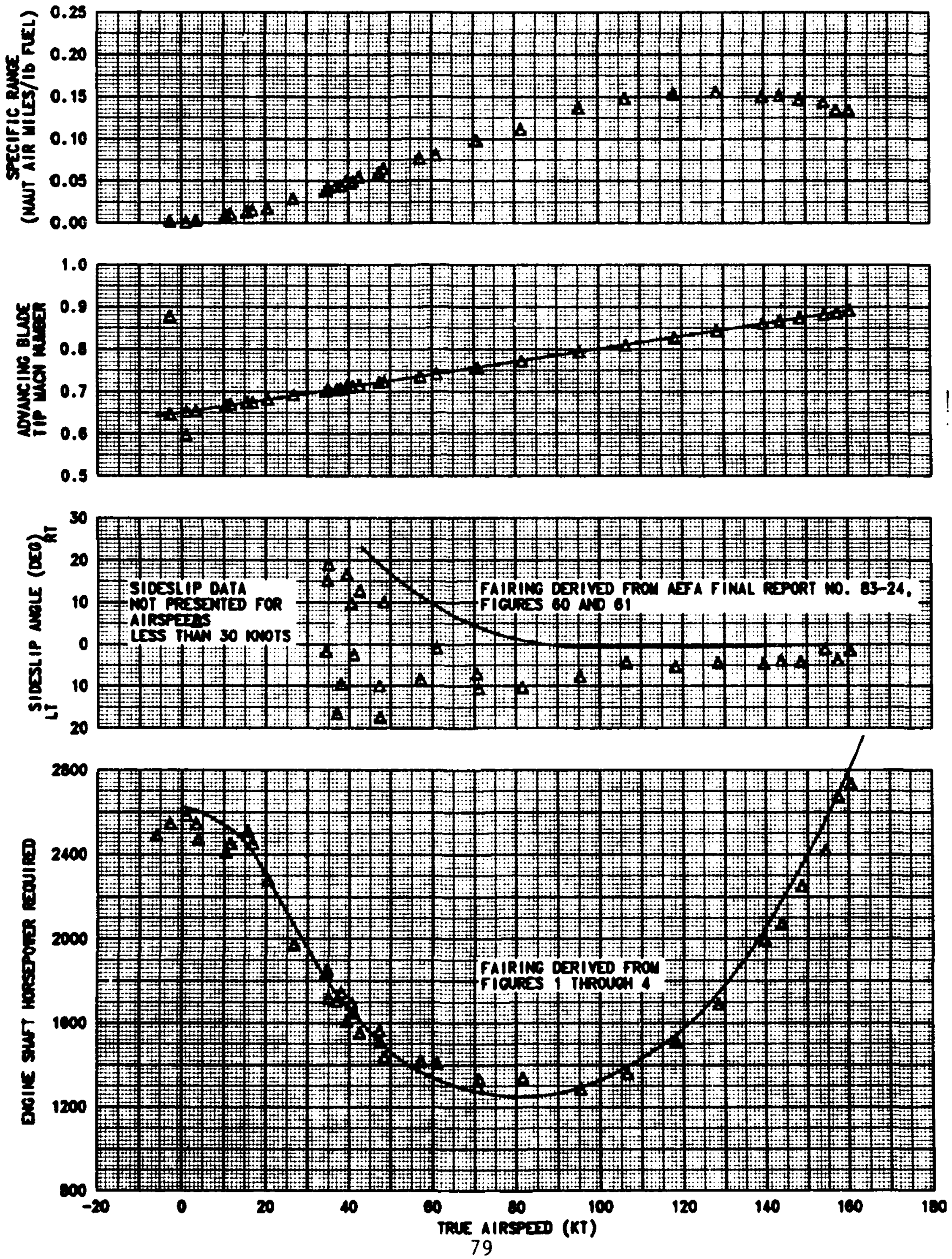


FIGURE E-8

CLIMB AND POWERED DESCENT PERFORMANCE

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	258.2	0.006619
○	17330	360.9(AFT)	5400	6.0	259.0	0.007379
△	19400	361.1(AFT)	5160	7.0	258.4	0.008209

NOTES:
1. SHADED SYMBOLS DENOTE TRIM LEVEL FLIGHT
2. DATA OBTAINED USING INTERMEDIATE RATED POWER
3. BALL-CENTERED FLIGHT

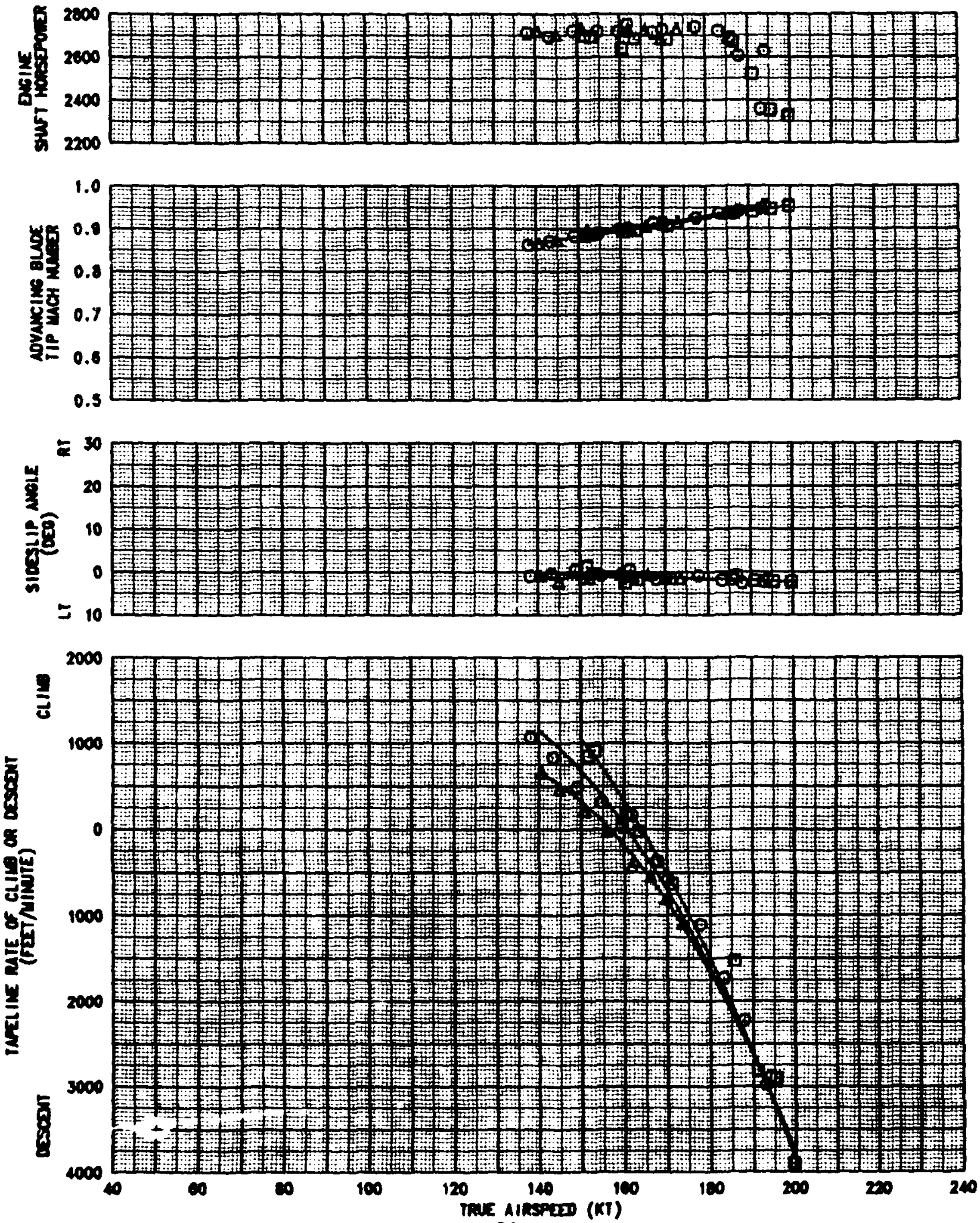


FIGURE E-9

EXTRAPOLATED LEVEL FLIGHT PERFORMANCE

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG REFERRED ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	258.2	0.006619
○	17330	360.9(AFT)	5400	6.0	259.0	0.007379
△	19400	361.1(AFT)	5160	7.0	258.4	0.008209

NOTES: 1. DATA DETERMINED FROM
a. CLIMB AND POWERED DESCENT RATES OF ALTITUDE CHANGE; FIGURE 8
b. POWER CORRECTION FACTOR = 0.76
c. $$\text{POWER REQD} = \text{POWER REQD FOR LEVEL FLIGHT AT } V_H + \frac{(\text{RATE OF CLIMB/DESCENT}) \times \text{GROSS WEIGHT}}{33000 \times \text{POWER CORRECTION FACTOR}}$$

2. BALL-CENTERED TRIM
3. FAIRINGS UP TO MAXIMUM AIRSPEED FOR LEVEL FLIGHT (V_H) DERIVED FROM FIGURES 1 THROUGH 4

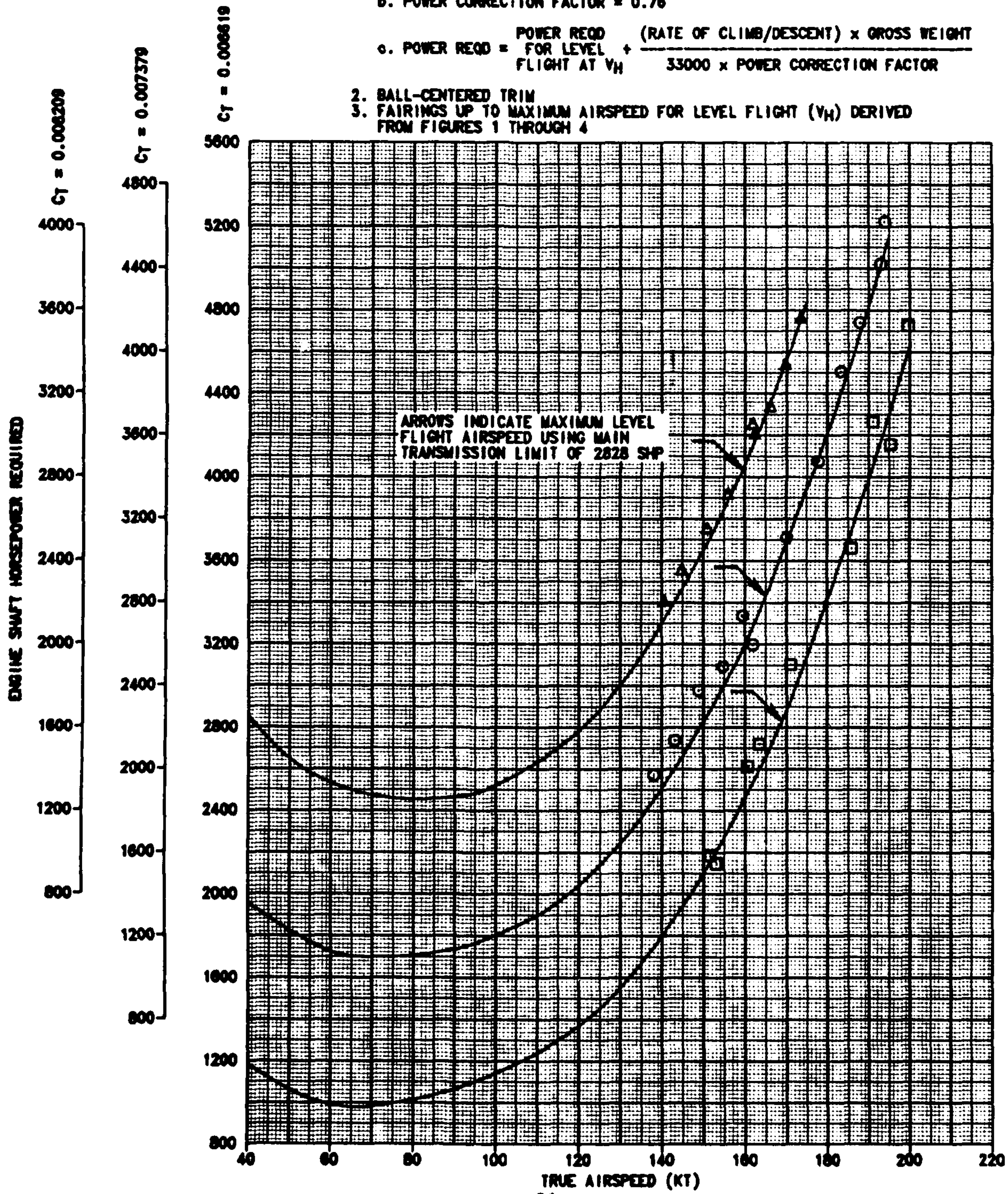


FIGURE E-10
CONTROL POSITIONS IN TRIMMED LEVEL FLIGHT
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15560	361.0(AFT)	5750	12.5	258.9	0.006595
⊙	17080	360.8(AFT)	6830	14.0	257.5	0.007465
△	19040	360.5(AFT)	6800	15.5	258.5	0.008252

NOTE: BALL-CENTERED FLIGHT

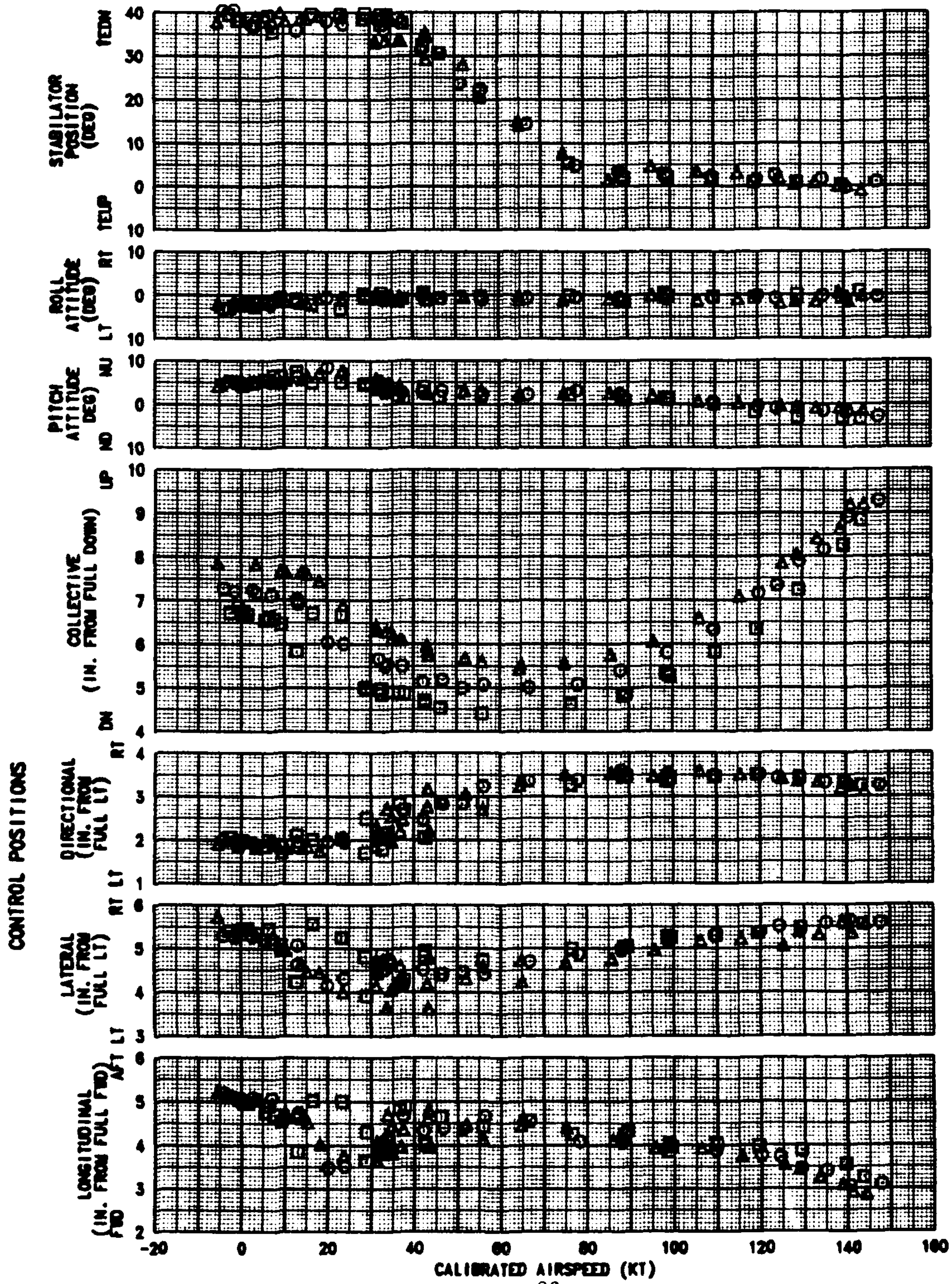


FIGURE E-11
CONTROL POSITIONS IN CLIMBS AND POWERED DESCENTS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊡	15570	361.3(AFT)	5960	13.0	257.3	0.006619
⊙	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5160	7.0	254.8	0.008252

NOTES: 1. SHADED SYMBOLS DENOTE TRIM LEVEL FLIGHT
2. DATA OBTAINED USING INTERMEDIATE RATED POWER
3. BALL-CENTERED FLIGHT

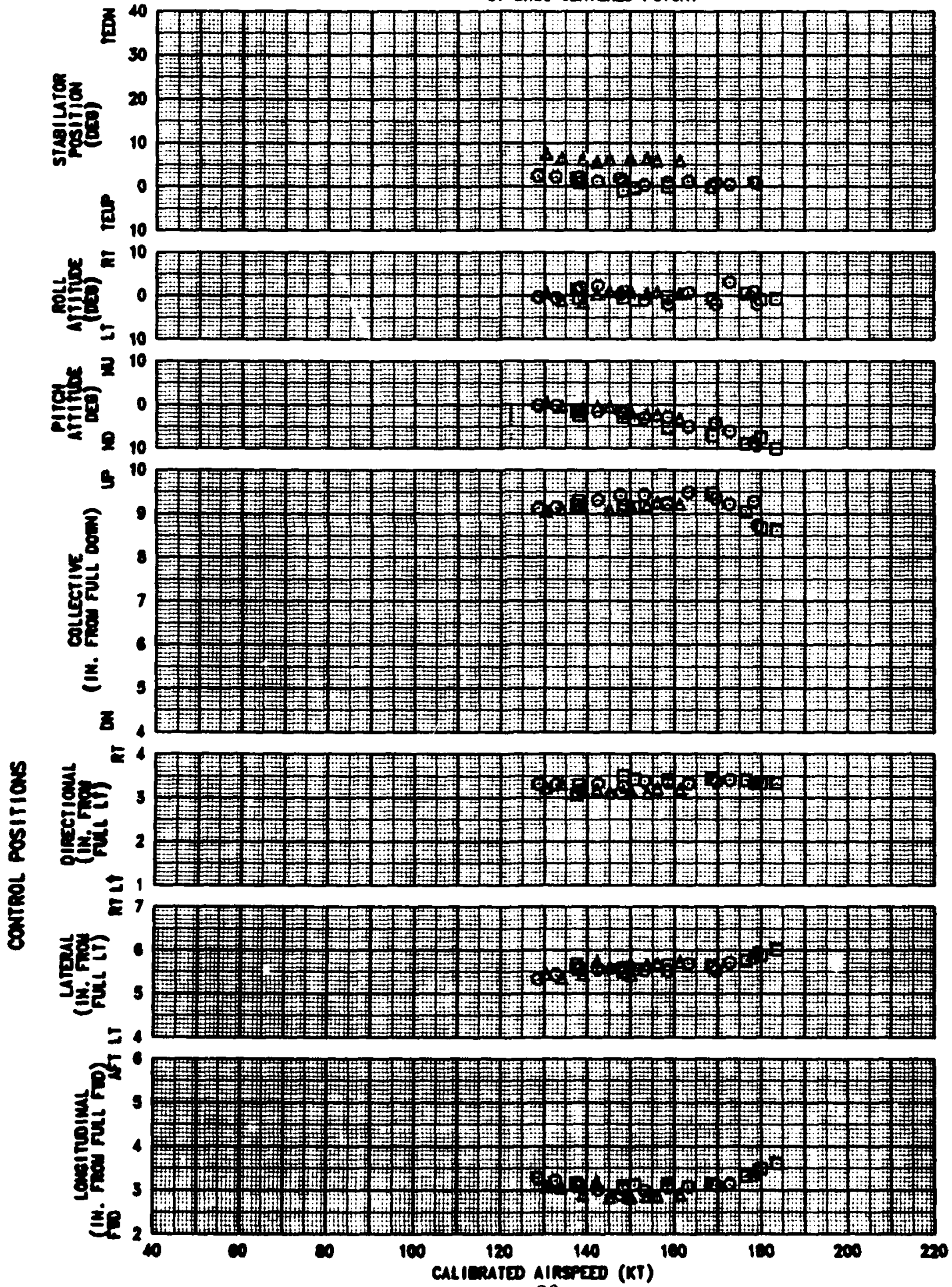


FIGURE E-12
MAIN ROTOR PRIMARY SERVO AND MIXER POSITIONS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊡	15560	361.0(AFT)	5750	12.5	258.5	0.006595
⊙	17080	360.8(AFT)	6930	14.0	258.2	0.007465
Δ	19040	360.5(AFT)	6900	15.5	258.5	0.008252

NOTE: BALL-CENTERED FLIGHT

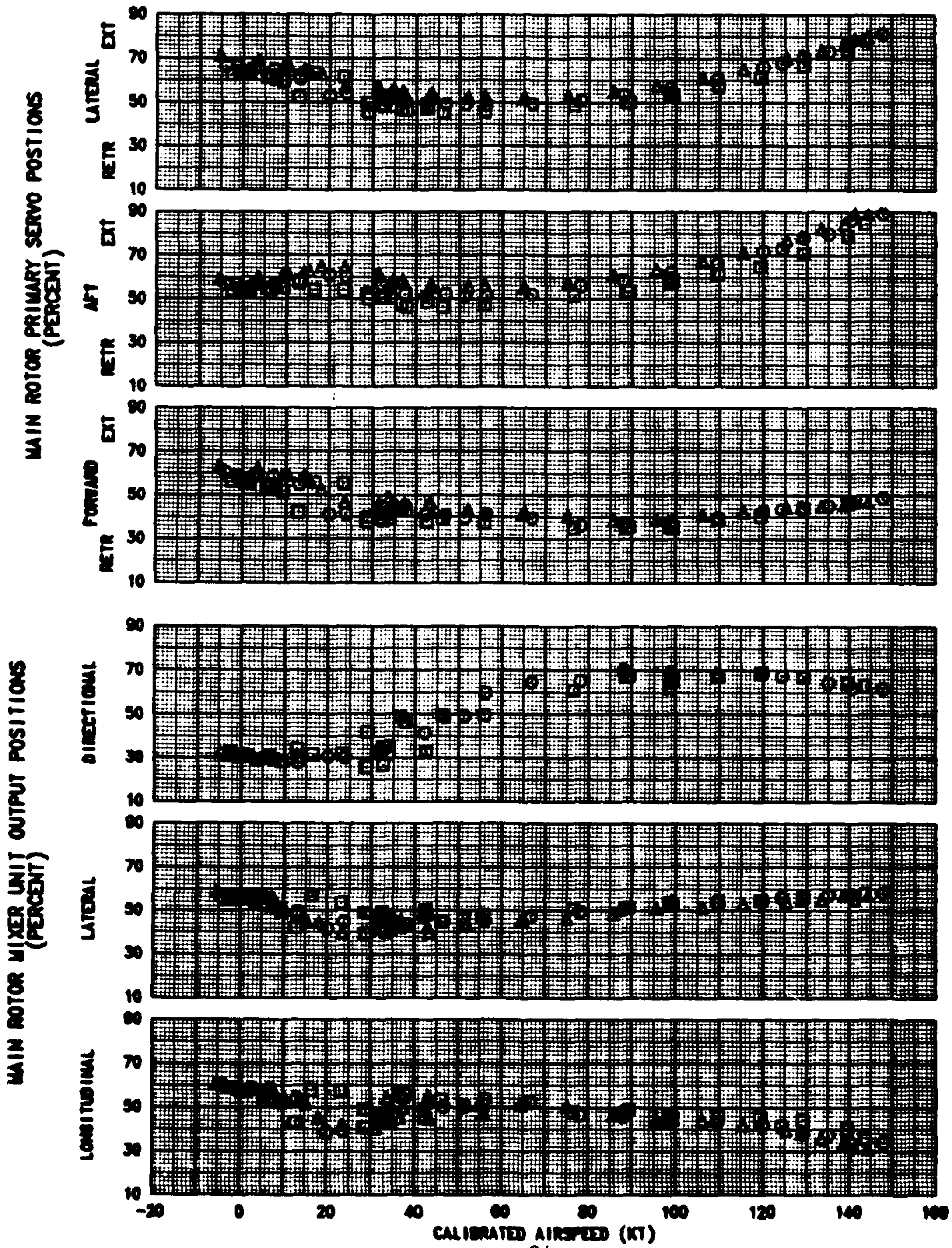


FIGURE E-13
MAIN ROTOR PRIMARY SERVO AND MIXER POSITIONS IN CLIMBS AND POWERED DESCENTS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	257.3	0.006619
○	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5160	7.0	254.8	0.008252

NOTES: 1. SHADED SYMBOLS DENOTE TRIM LEVEL FLIGHT
2. DATA OBTAINED USING INTERMEDIATE RATED POWER
3. BALL-CENTERED FLIGHT

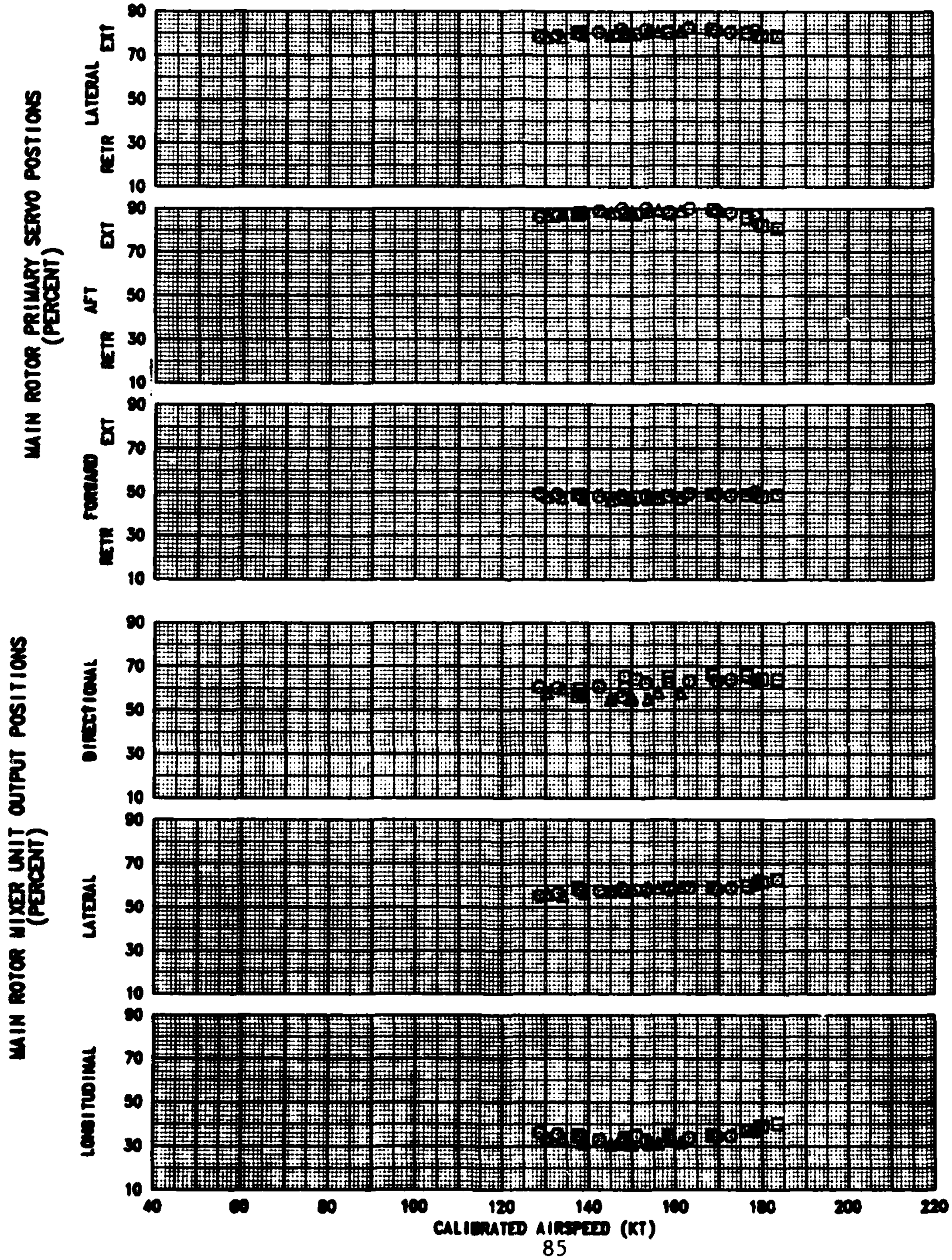


FIGURE E-14
MEASURED MAIN ROTOR BLADE POSITIONS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15560	361.0(AFT)	5750	12.5	256.9	0.006595
○	17080	360.8(AFT)	6930	14.0	257.5	0.007465
△	19040	360.5(AFT)	6900	15.5	258.5	0.008252

NOTE: BALL-CENTERED FLIGHT

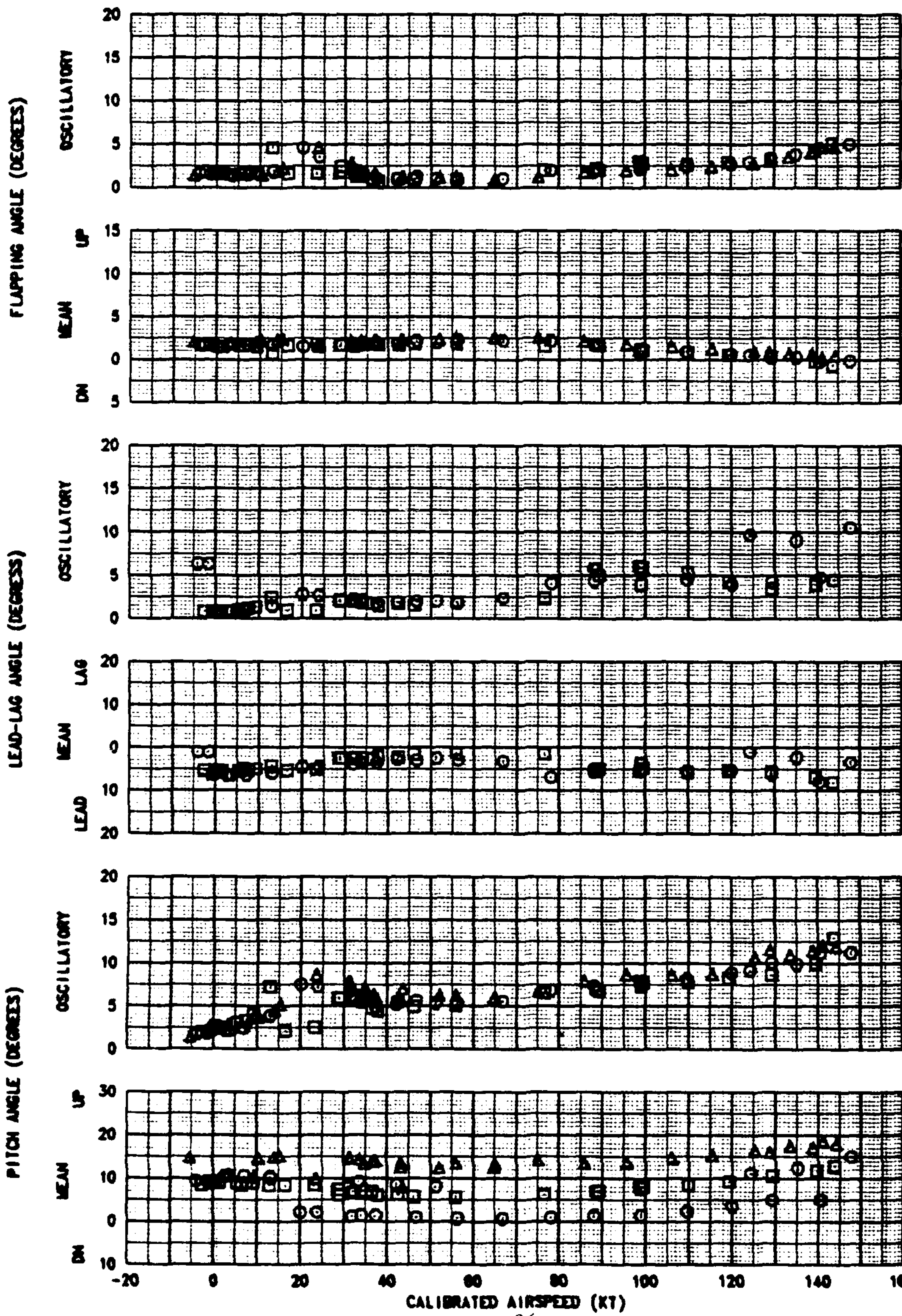


FIGURE E-15
MEASURED MAIN ROTOR BLADE POSITIONS IN CLIMBS AND POWERED DESCENTS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	257.3	0.006619
○	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5160	7.0	254.8	0.008252

NOTES:
1. SHADED SYMBOL DENOTES LEVEL FLIGHT
2. DATA OBTAINED USING INTERMEDIATE RATED POWER
3. BALL-CENTERED FLIGHT

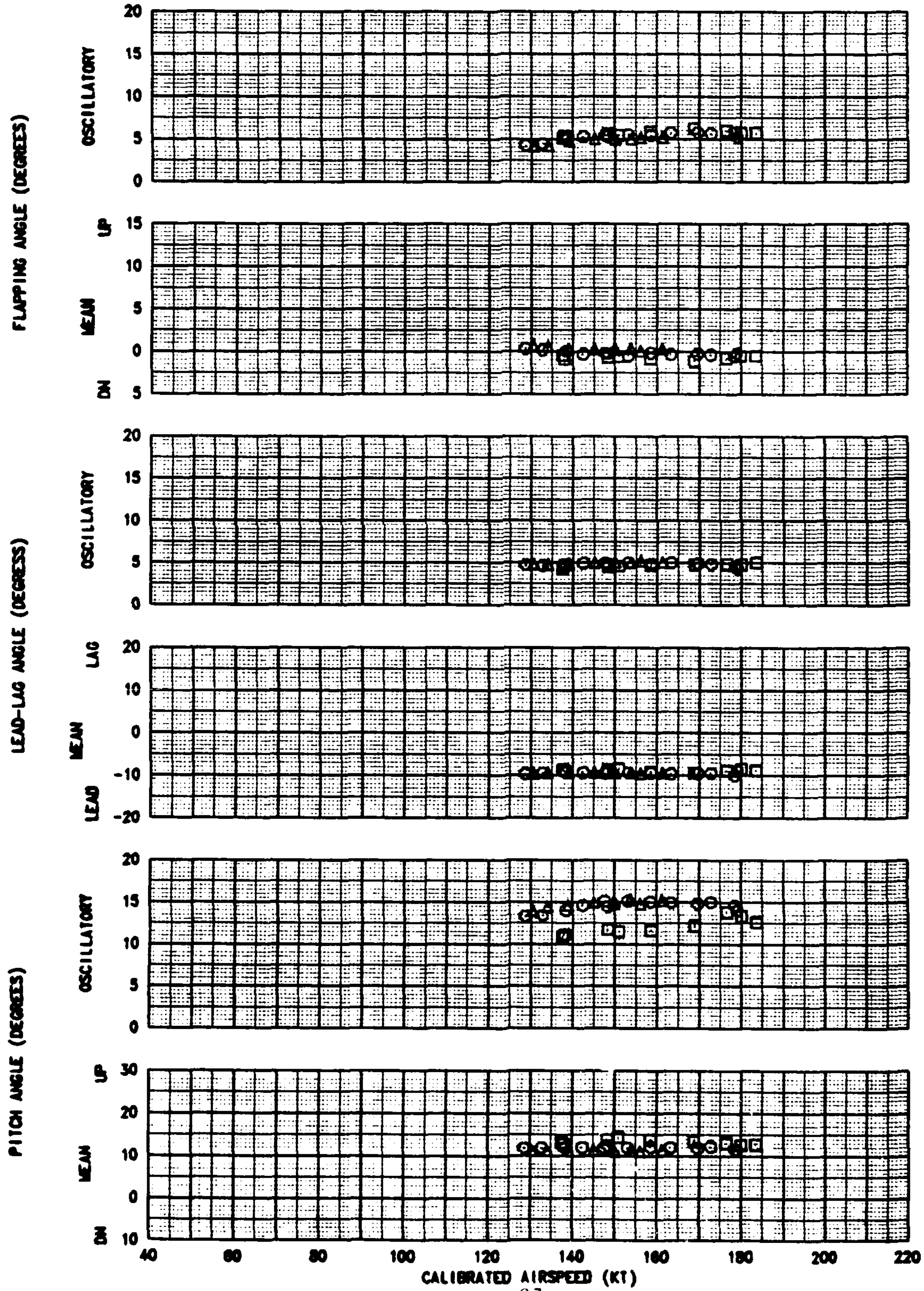


FIGURE E-16
CONTROL POSITIONS IN TURNING FLIGHT AT 122 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊡	15540	359.9 (AFT)	6160	14.0	258.2	0.006600
⊙	16140	360.7 (AFT)	8130	8.0	254.7	0.007486
Δ	17790	360.6 (AFT)	7870	8.5	255.1	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

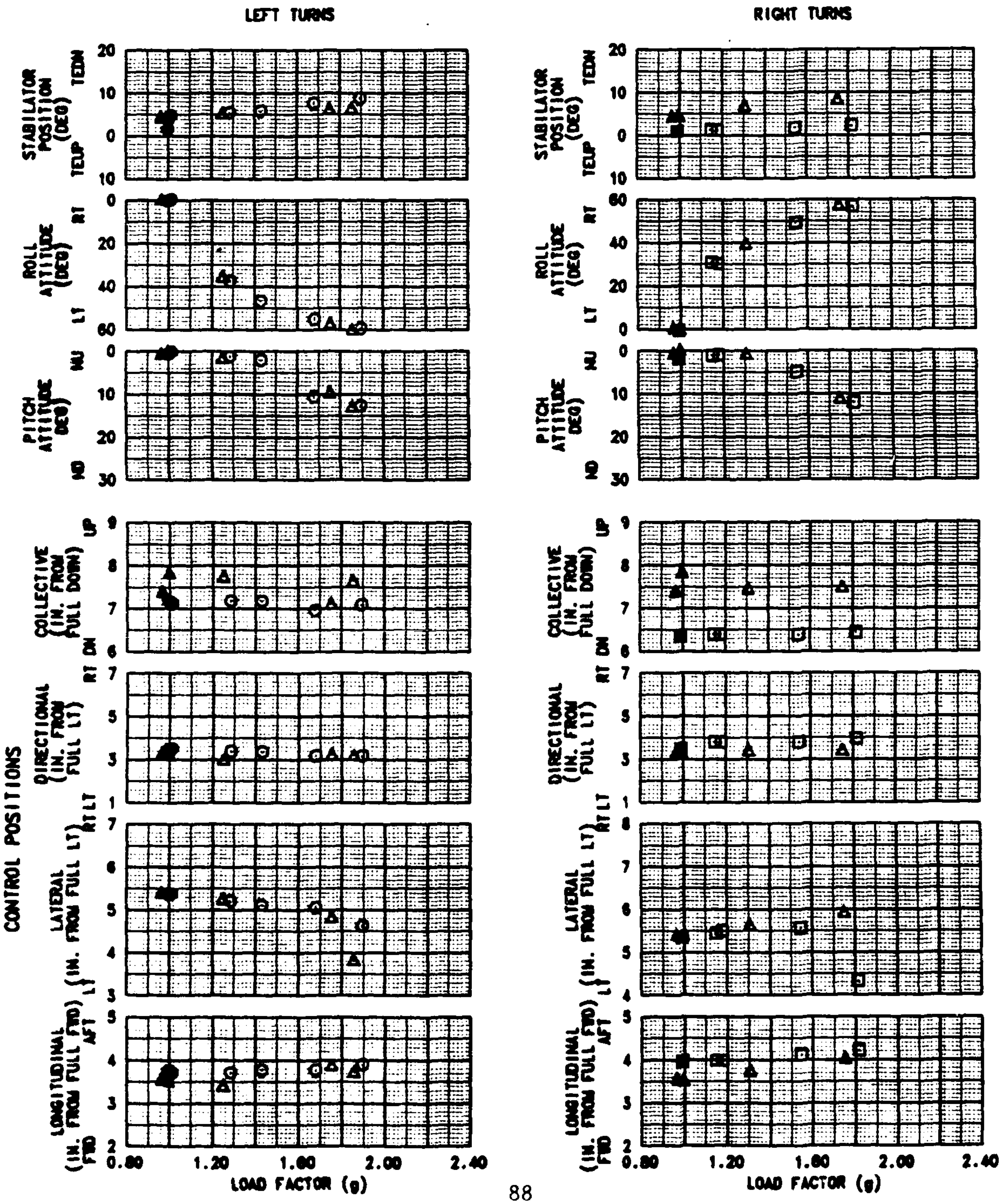


FIGURE E-17
CONTROL POSITIONS IN TURNING FLIGHT AT 140 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15700	361.1 (AFT)	8850	6.0	254.5	0.007458
△	17570	360.7 (AFT)	8000	3.0	252.6	0.008251

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

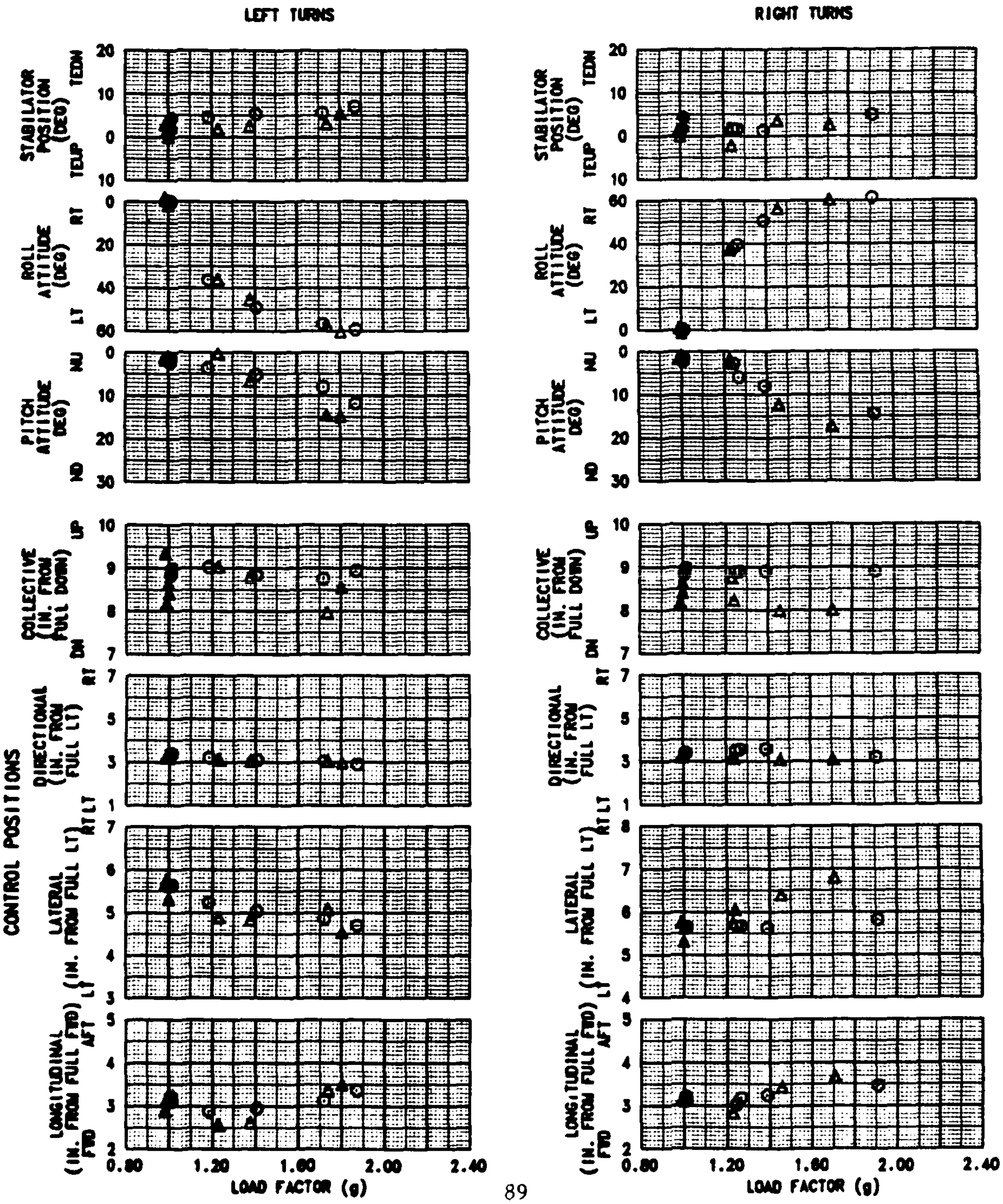


FIGURE E-18
CONTROL POSITIONS IN TURNING FLIGHT AT 150 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15610	361.2 (AFT)	8820	6.5	254.2	0.007426
△	17200	360.7 (AFT)	8380	1.0	251.1	0.008271

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

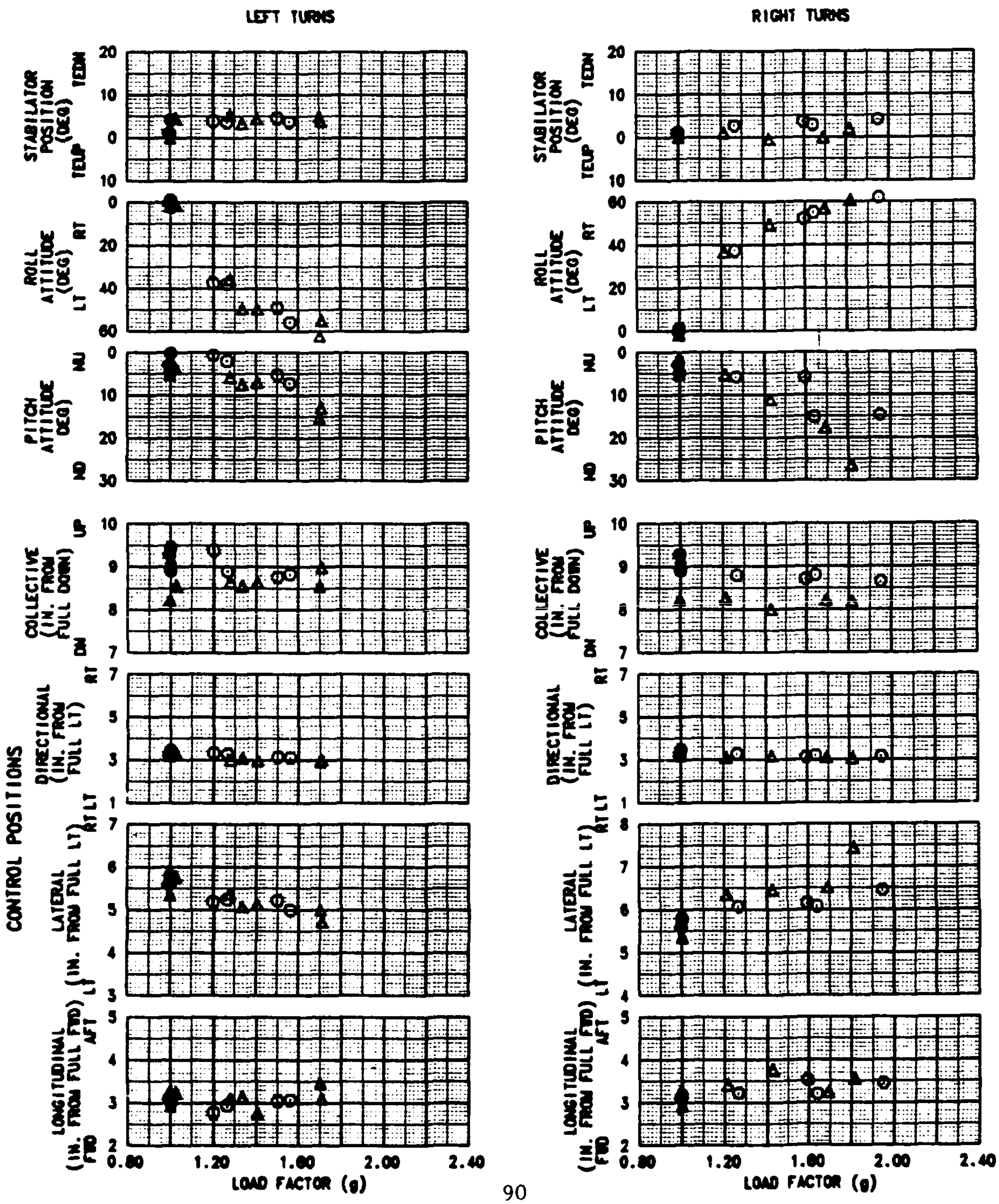


FIGURE E-19
CONTROL POSITIONS IN TURNING FLIGHT AT 160 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15920	360.7 (AFT)	8600	8.0	255.5	0.007451
Δ	17100	360.8 (AFT)	9080	4.5	253.0	0.008279

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

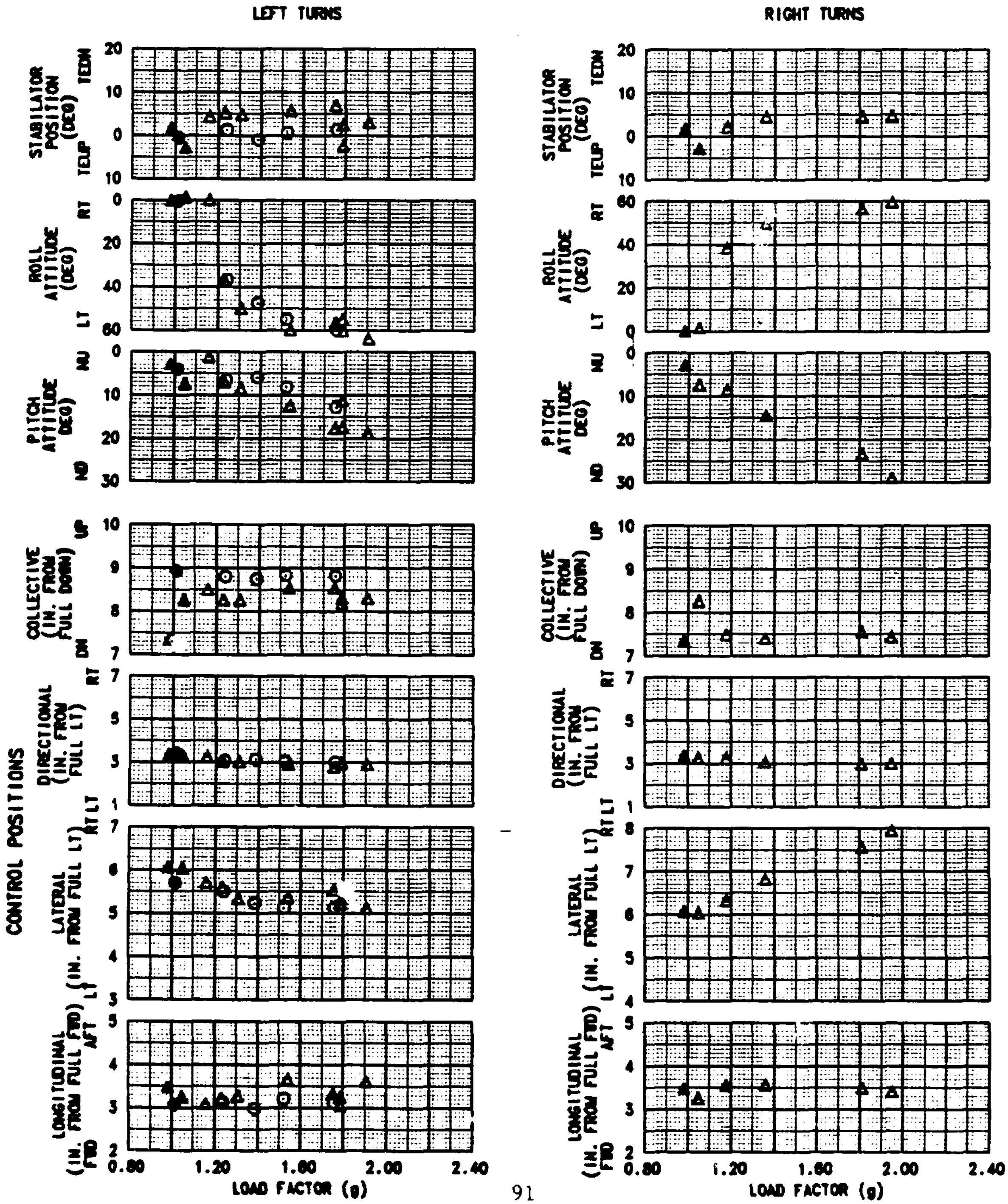


FIGURE E-21
MAIN ROTOR PRIMARY SERVO AND MIXER POSITIONS IN TURNING FLIGHT AT 122 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15540	359.9 (AFT)	6160	14.0	258.2	0.006600
⊙	16140	360.7 (AFT)	8130	8.0	254.7	0.007486
△	17790	360.6 (AFT)	7870	8.5	255.1	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

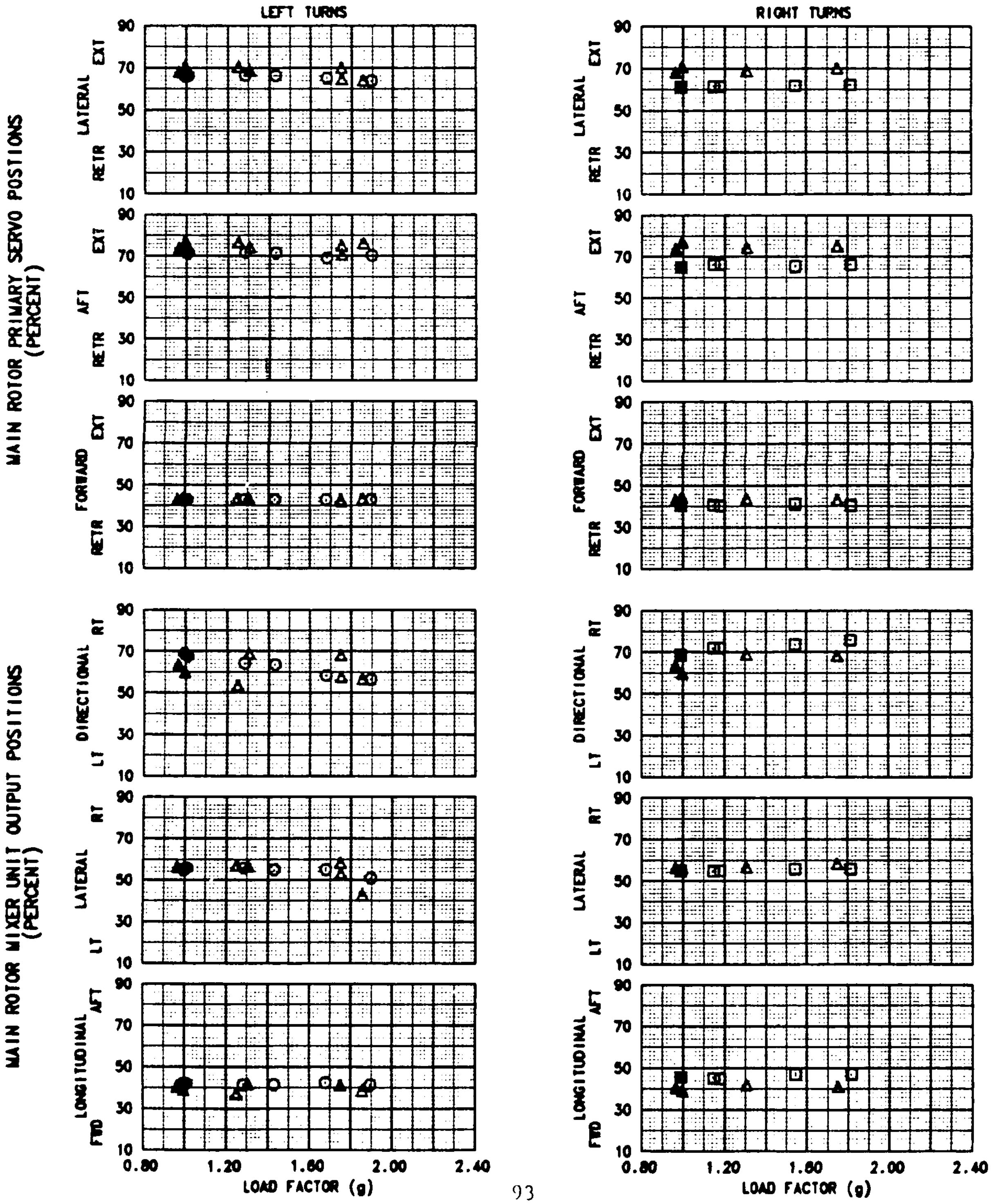


FIGURE E-22
MAIN ROTOR PRIMARY SERVO AND MIXER POSITIONS IN TURNING FLIGHT AT 140 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15700	361.1 (AFT)	8850	6.0	254.5	0.007458
○	17570	360.7 (AFT)	8000	3.0	252.6	0.008251
△						

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

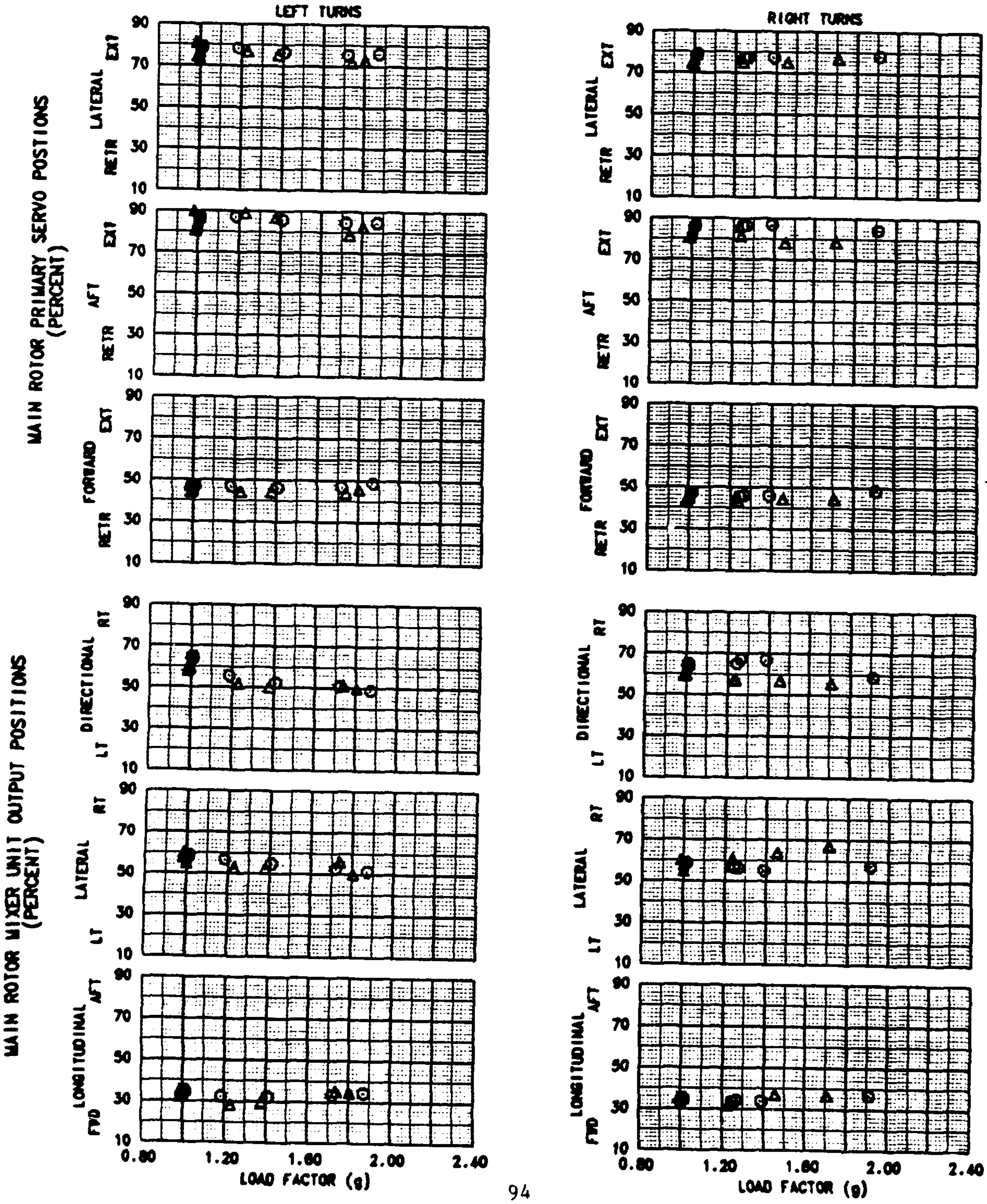


FIGURE E-20
CONTROL POSITIONS IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15400	361.5 (AFT)	9040	6.6	253.6	0.007388
△	17280	361.6 (AFT)	9130	9.0	254.8	0.008260

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

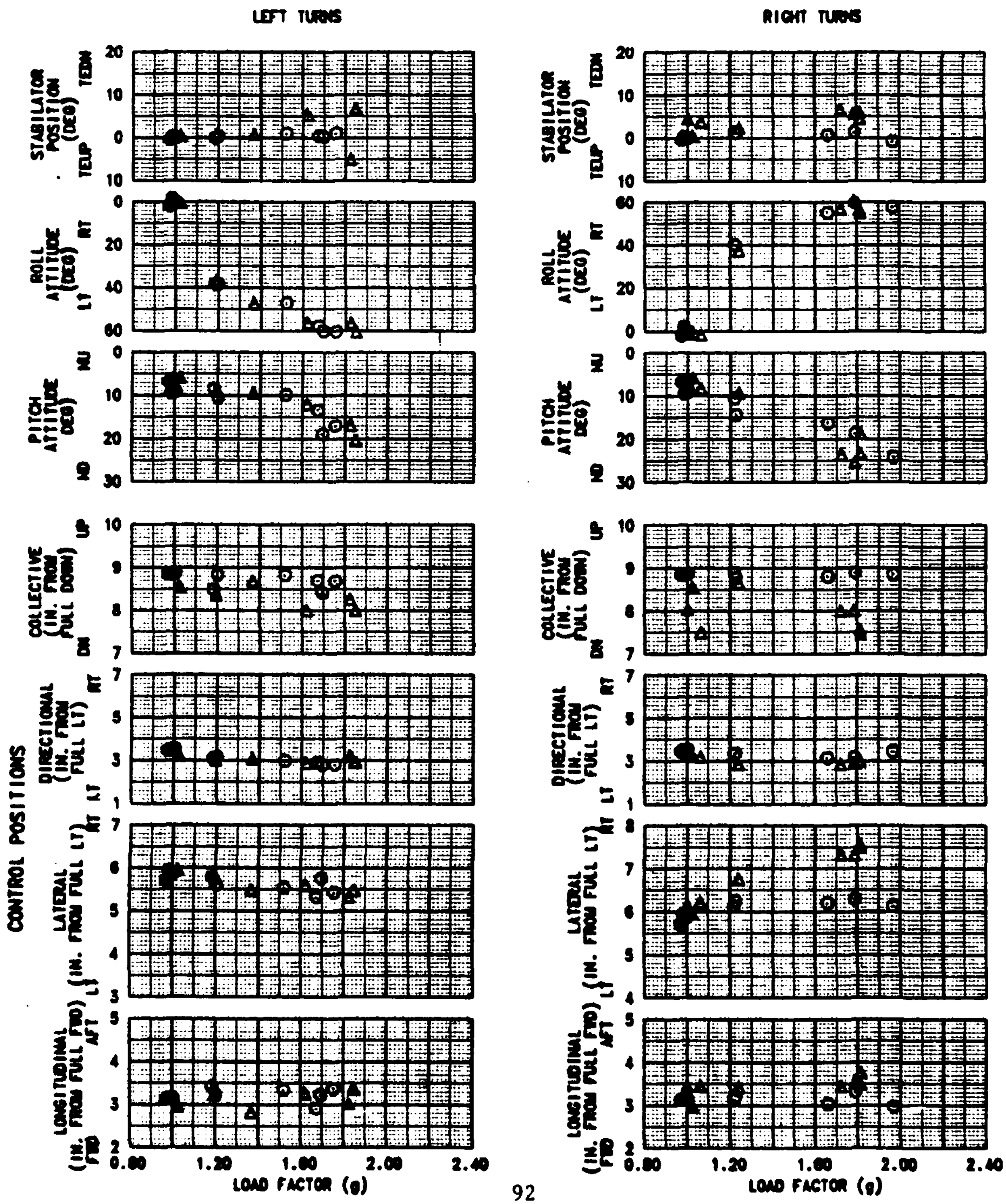


FIGURE E-25

MAIN ROTOR PRIMARY SERVO AND MIXER POSITIONS IN TURNING FLIGHT AT 150 KCAS

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15610	361.2 (AFT)	8020	8.5	264.2	0.007426
Δ	17200	360.7 (AFT)	8500	1.0	261.1	0.008271

NOTES:
1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

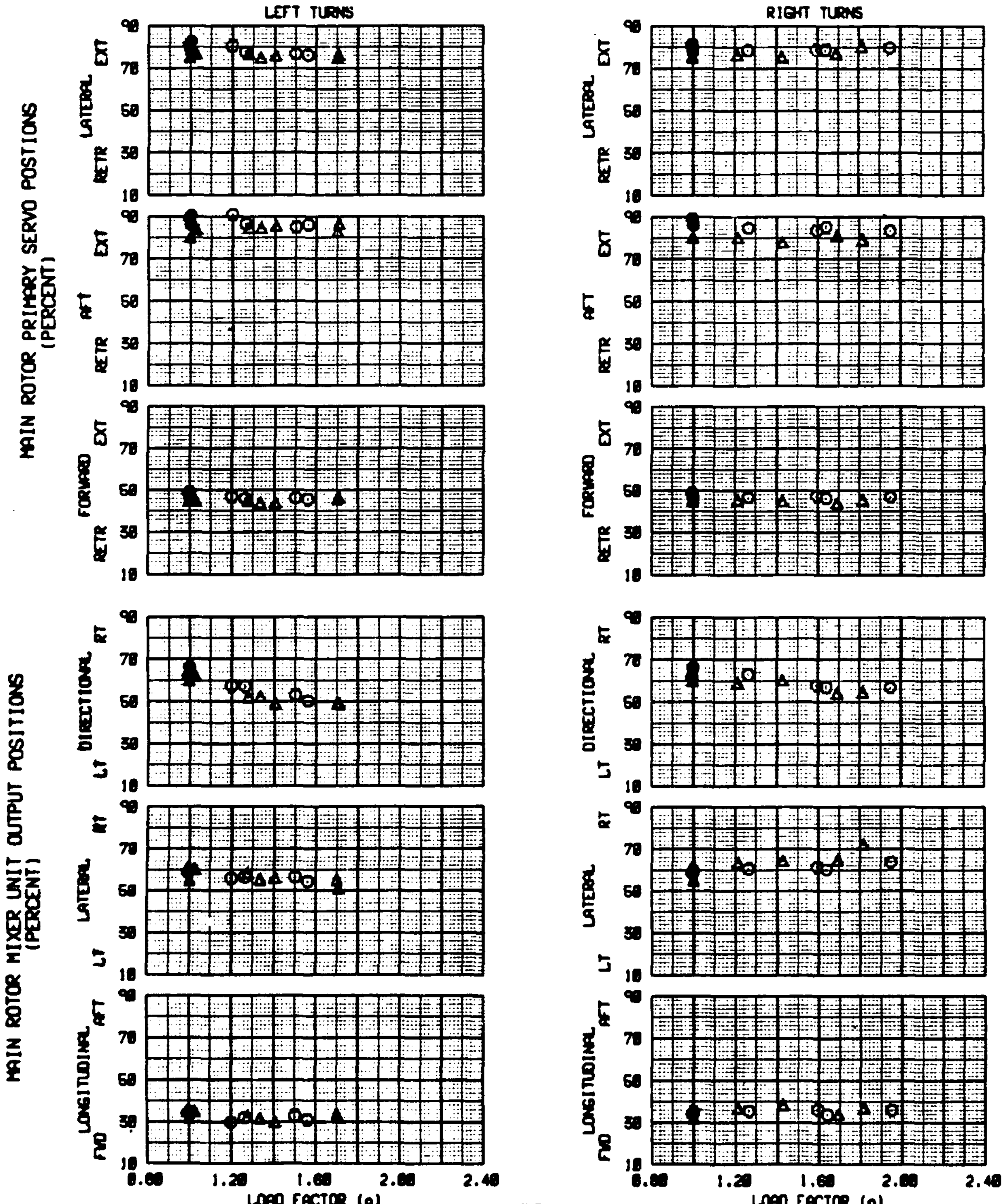


FIGURE E-24
MAIN ROTOR PRIMARY SERVO AND MIXER POSITIONS IN TURNING FLIGHT AT 160 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15920	360.7 (AFT)	8600	8.0	255.5	0.007451
△	17100	360.8 (AFT)	9180	4.5	253.0	0.008279

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

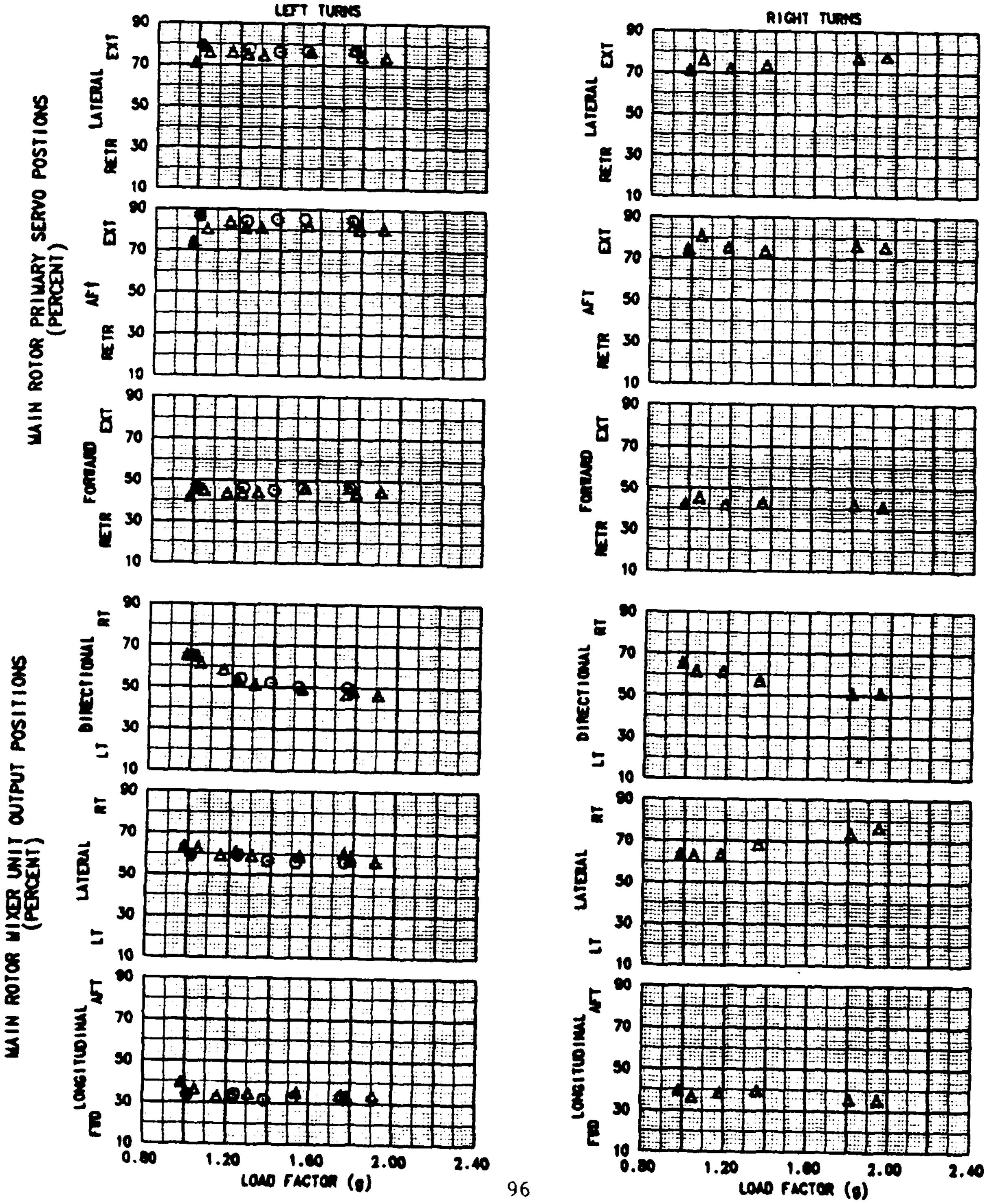


FIGURE E-25
MAIN ROTOR PRIMARY SERVO AND MIXER POSITIONS IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15400	361.5 (AFT)	8940	6.6	253.6	0.007388
△	17280	361.6 (AFT)	9130	9.0	254.8	0.008260

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

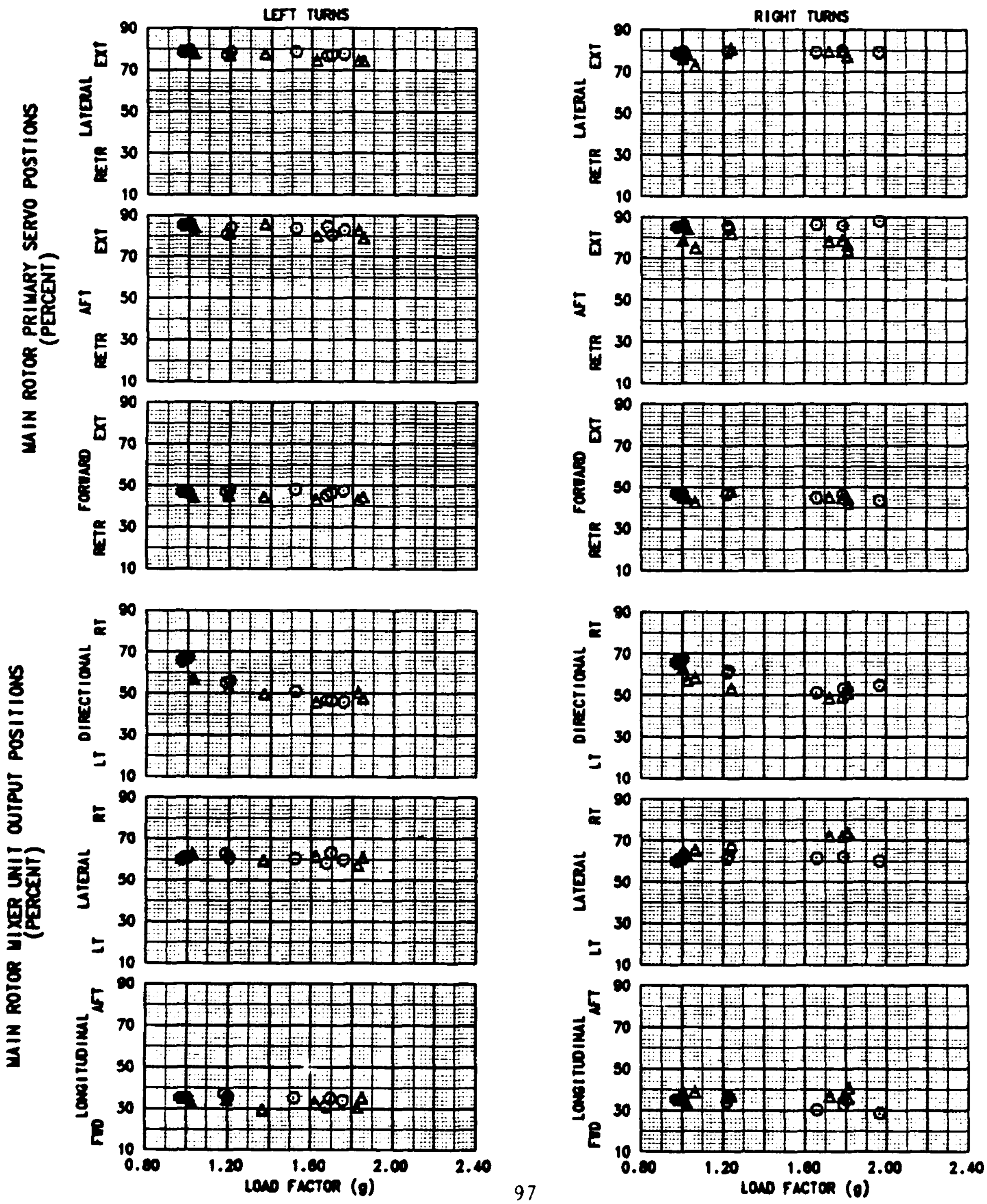


FIGURE E-26
MEASURED MAIN ROTOR BLADE POSITIONS IN TURNING FLIGHT AT 122 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15540	359.9 (AFT)	6160	14.0	258.2	0.006600
○	16140	360.7 (AFT)	8130	8.0	254.7	0.007486
△	17790	360.6 (AFT)	7870	4.5	255.1	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

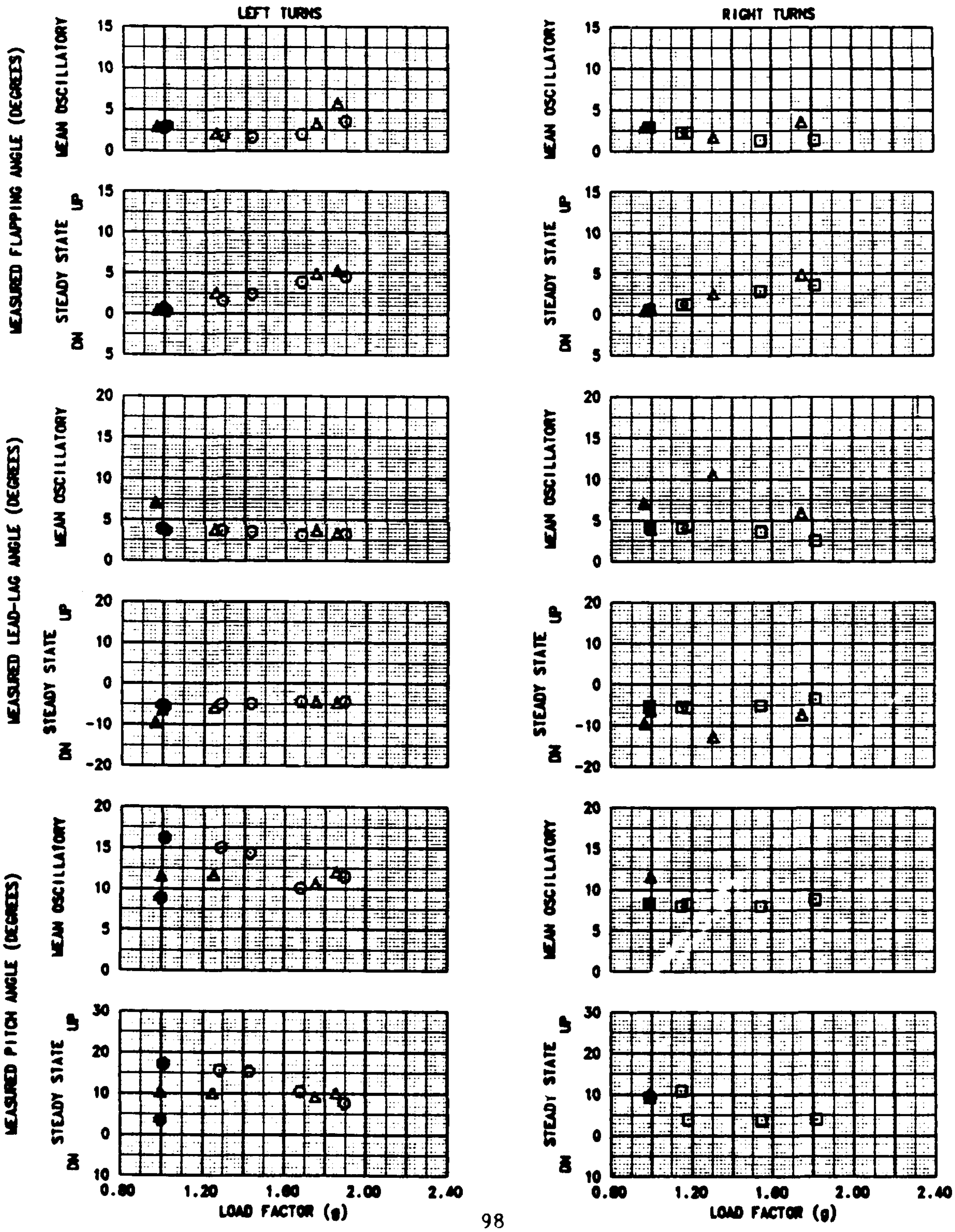


FIGURE E-27
MEASURED MAIN ROTOR BLADE POSITIONS IN TURNING FLIGHT AT 140 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15700	361.1 (AFT)	8850	6.0	254.5	0.007458
△	17570	360.7 (AFT)	8000	3.0	252.6	0.008251

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

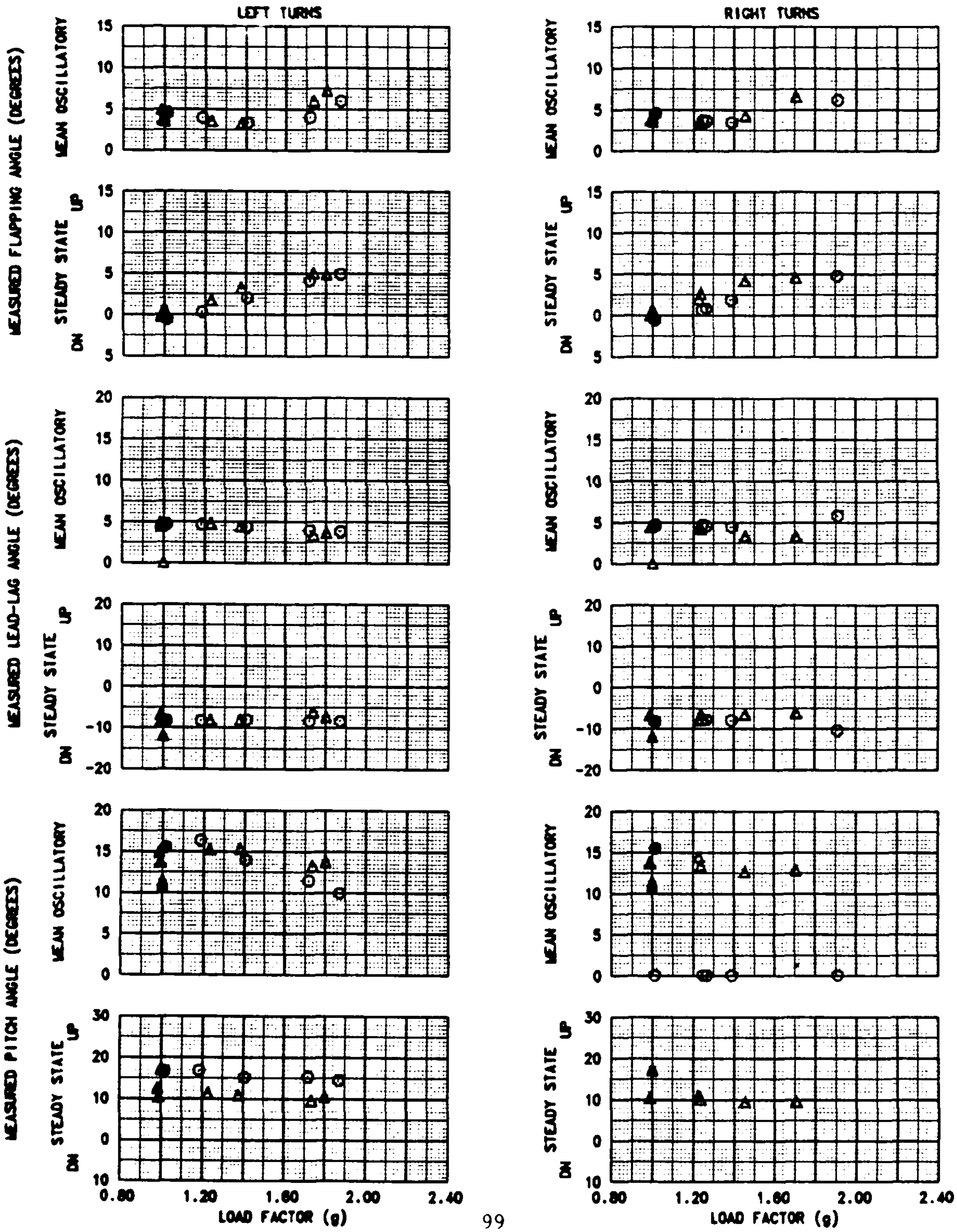


FIGURE E-28

MEASURED MAIN ROTOR BLADE POSITIONS IN TURNING FLIGHT AT 150 KCAS

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15610	361.2 (AFT)	8820	6.5	254.2	0.007426
△	17200	360.7 (AFT)	8380	1.0	251.1	0.008271

NOTES:
1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

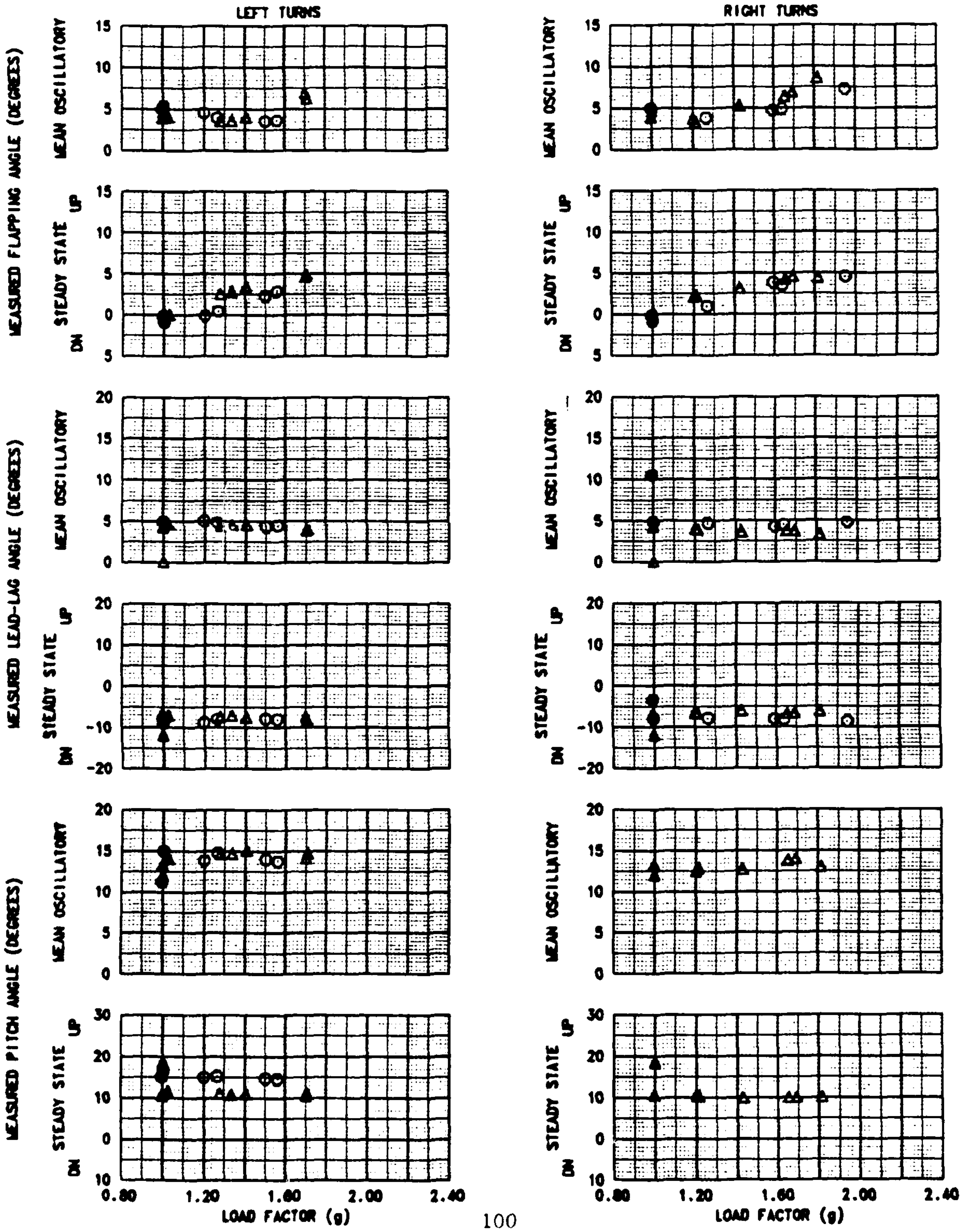


FIGURE E-29
MEASURED MAIN ROTOR BLADE POSITIONS IN TURNING FLIGHT AT 160 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15920	360.7 (AFT)	8600	8.0	255.5	0.007451
⊙	17100	360.8 (AFT)	9080	4.5	253.0	0.008279

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

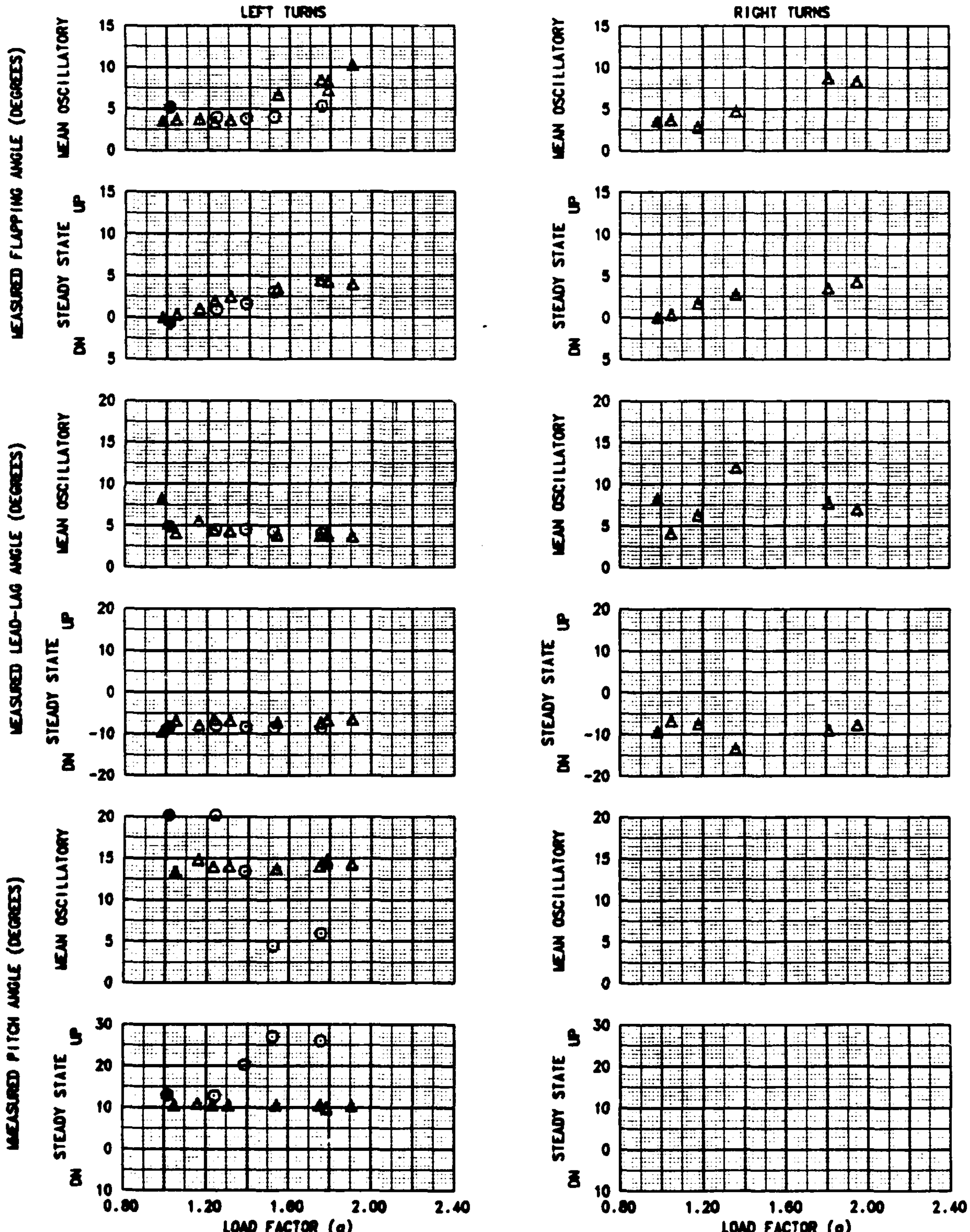


FIGURE E-30
MEASURED MAIN ROTOR BLADE POSITIONS IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15400	361.5 (AFT)	8840	6.6	253.6	0.007388
△	17280	361.6 (AFT)	9130	9.0	254.8	0.008280

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

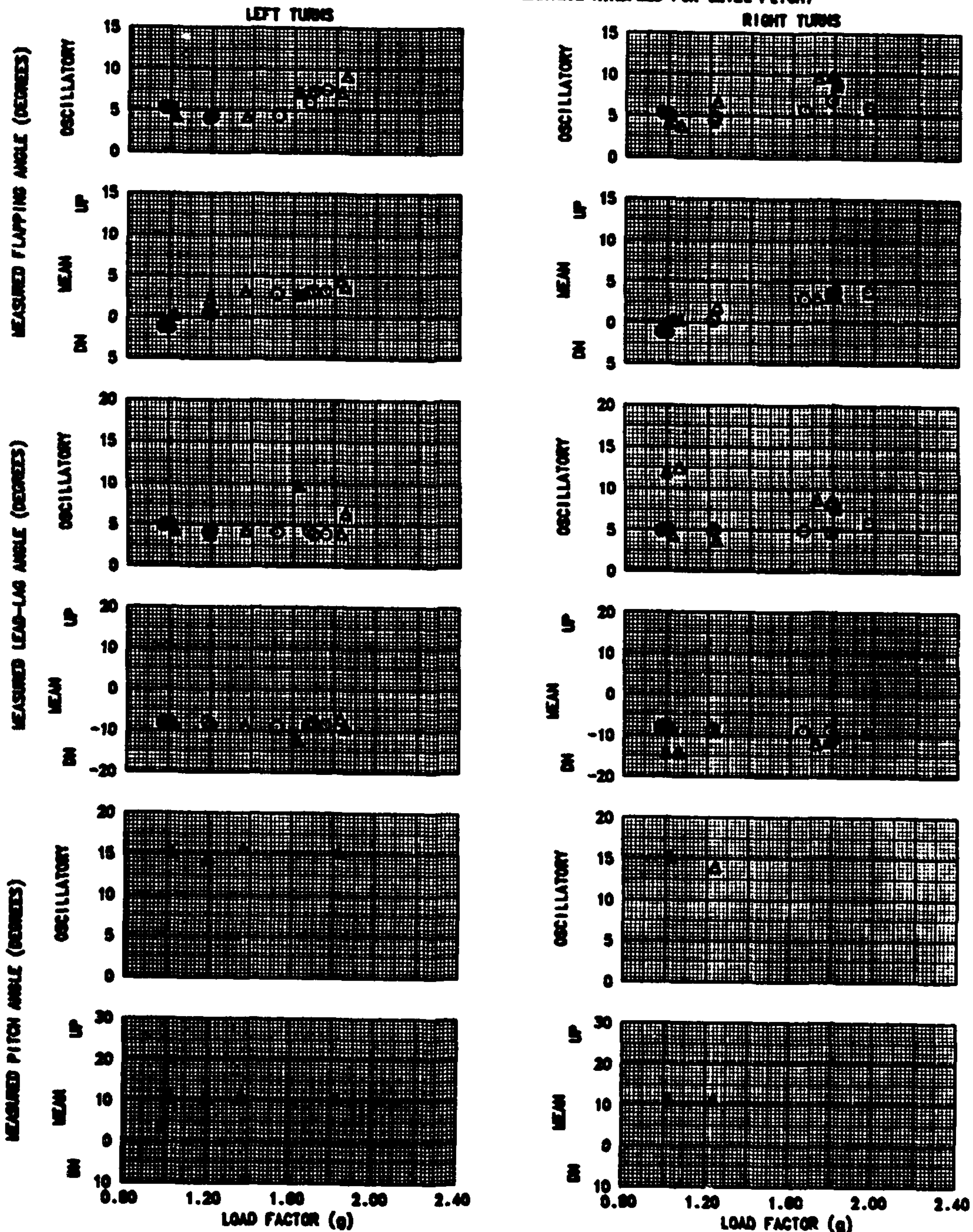


FIGURE E-31
DYNAMIC STABILITY
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
16090	350.9 (AFT)	5720	20.0	261	54

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

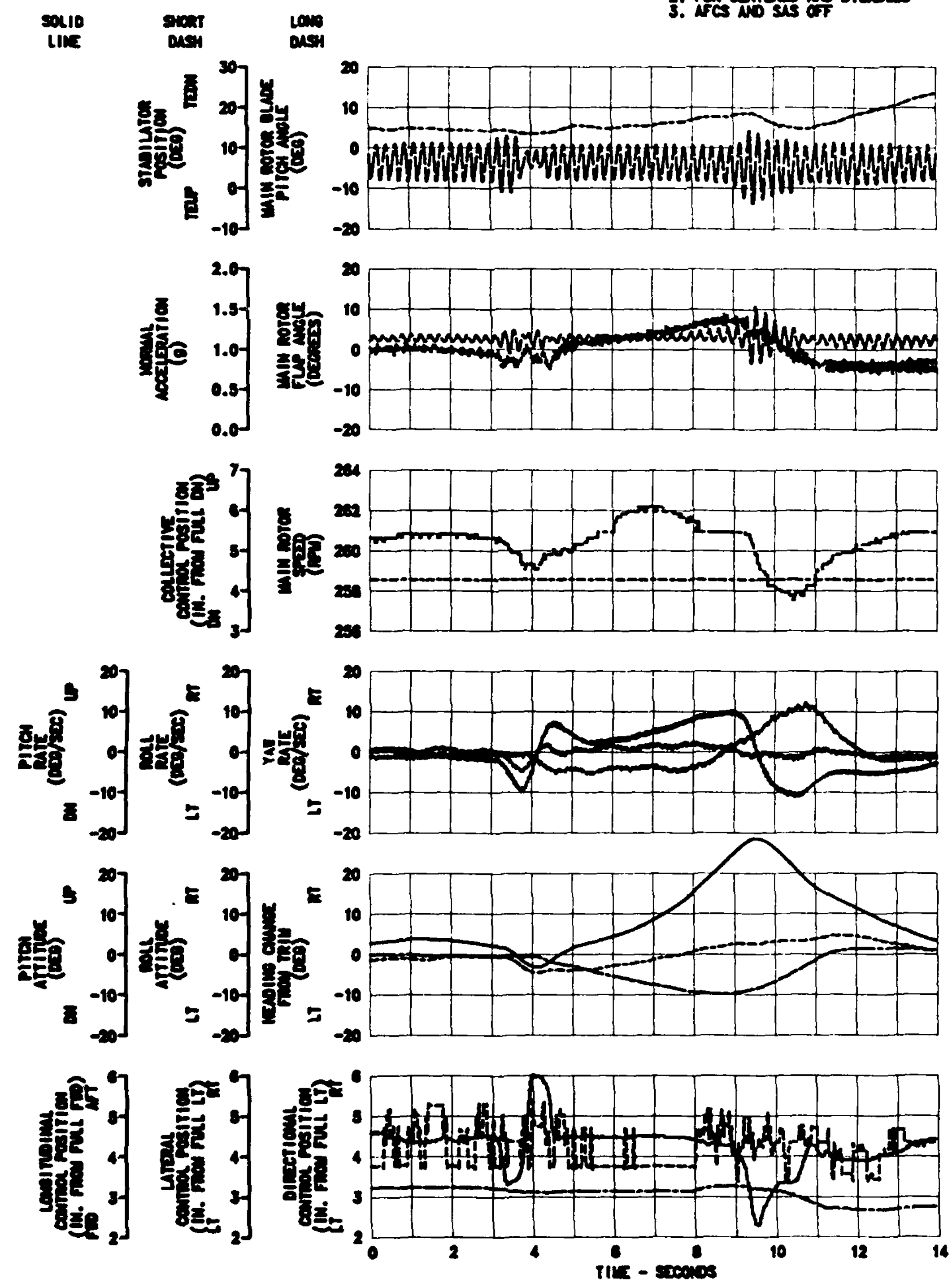


FIGURE E-32
DYNAMIC STABILITY
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
16000	350.8 (AFT)	5670	19.5	260	77

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

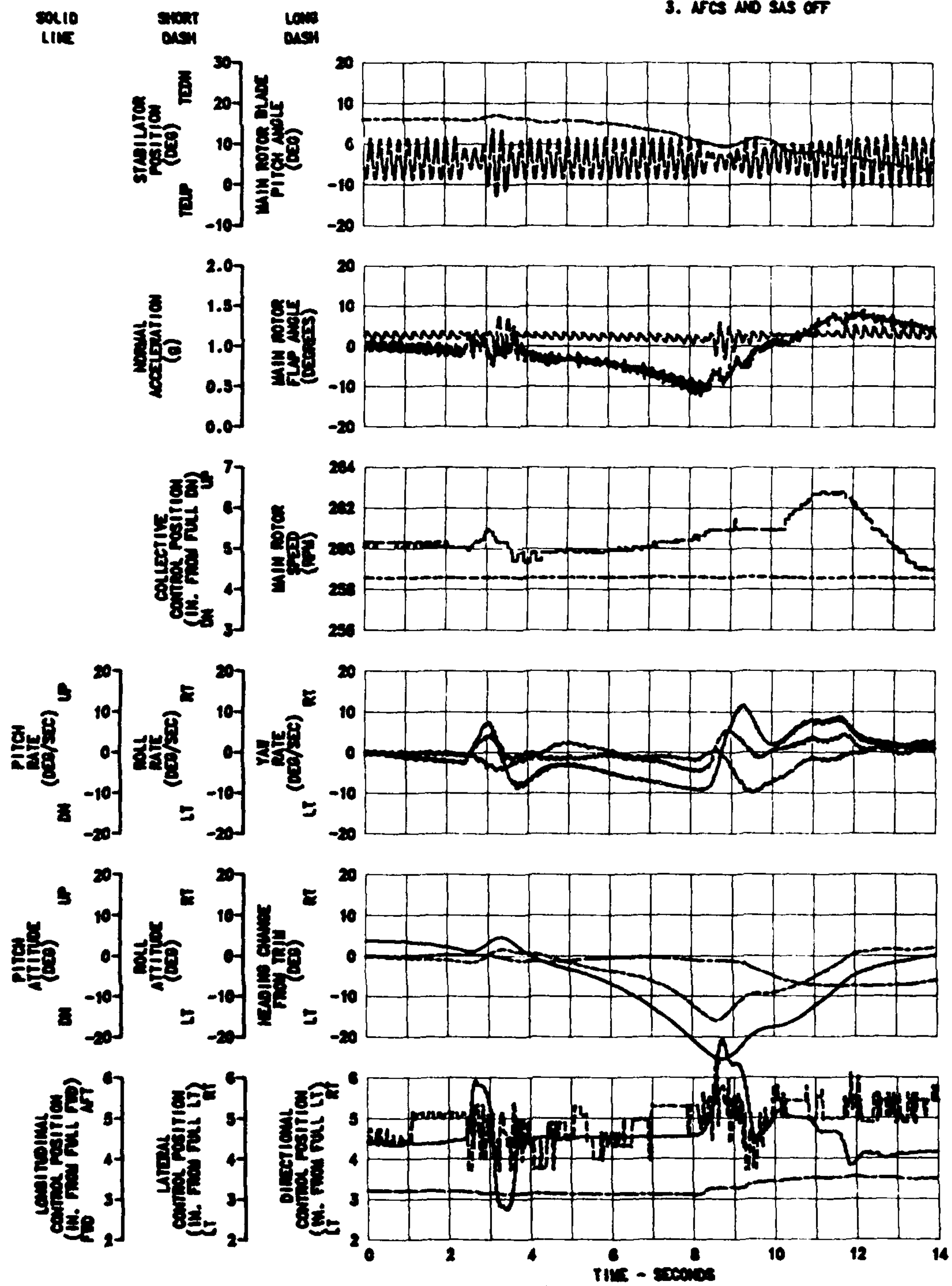


FIGURE E-33
DYNAMIC STABILITY
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
15940	350.8 (AFT)	5810	19.5	260	62

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

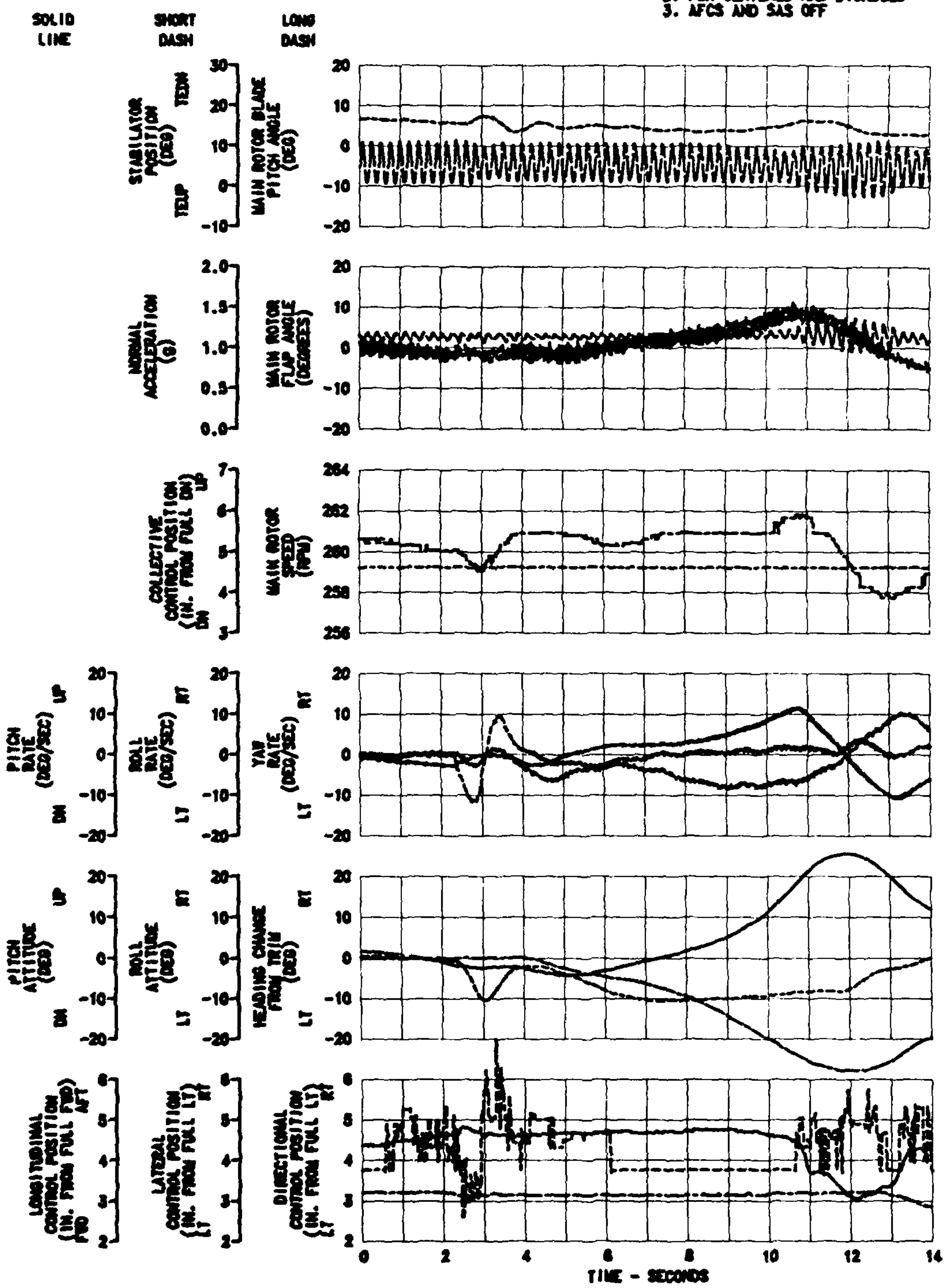


FIGURE E-34
DYNAMIC STABILITY
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
15650	350.8 (AFT)	5650	19.5	260	46

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

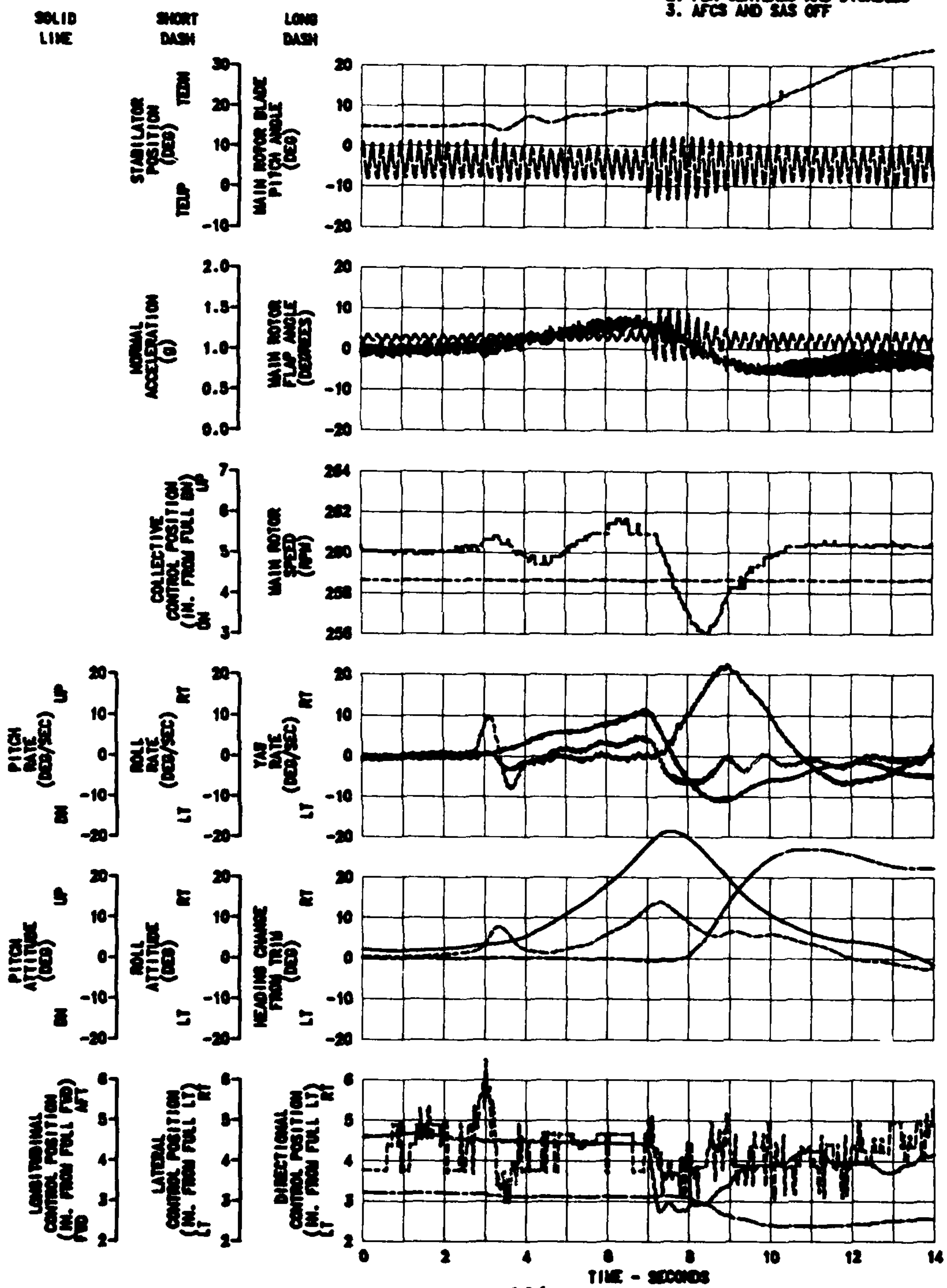


FIGURE E-35
DYNAMIC STABILITY
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
15730	350.9 (AFT)	6060	18.5	260	71

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

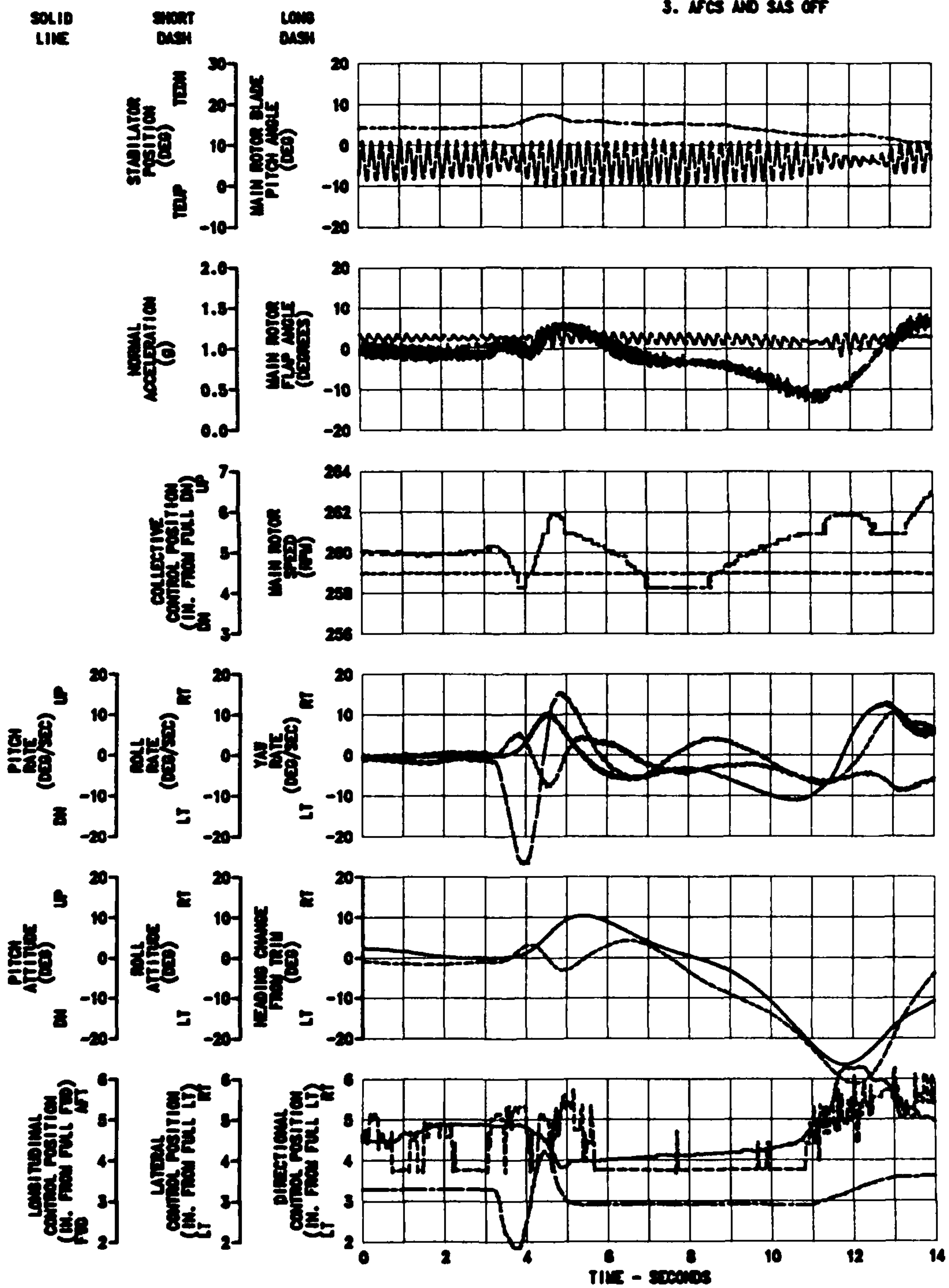


FIGURE E-36

DYNAMIC STABILITY

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
15700	360.7 (AFT)	6200	18.5	260	48

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

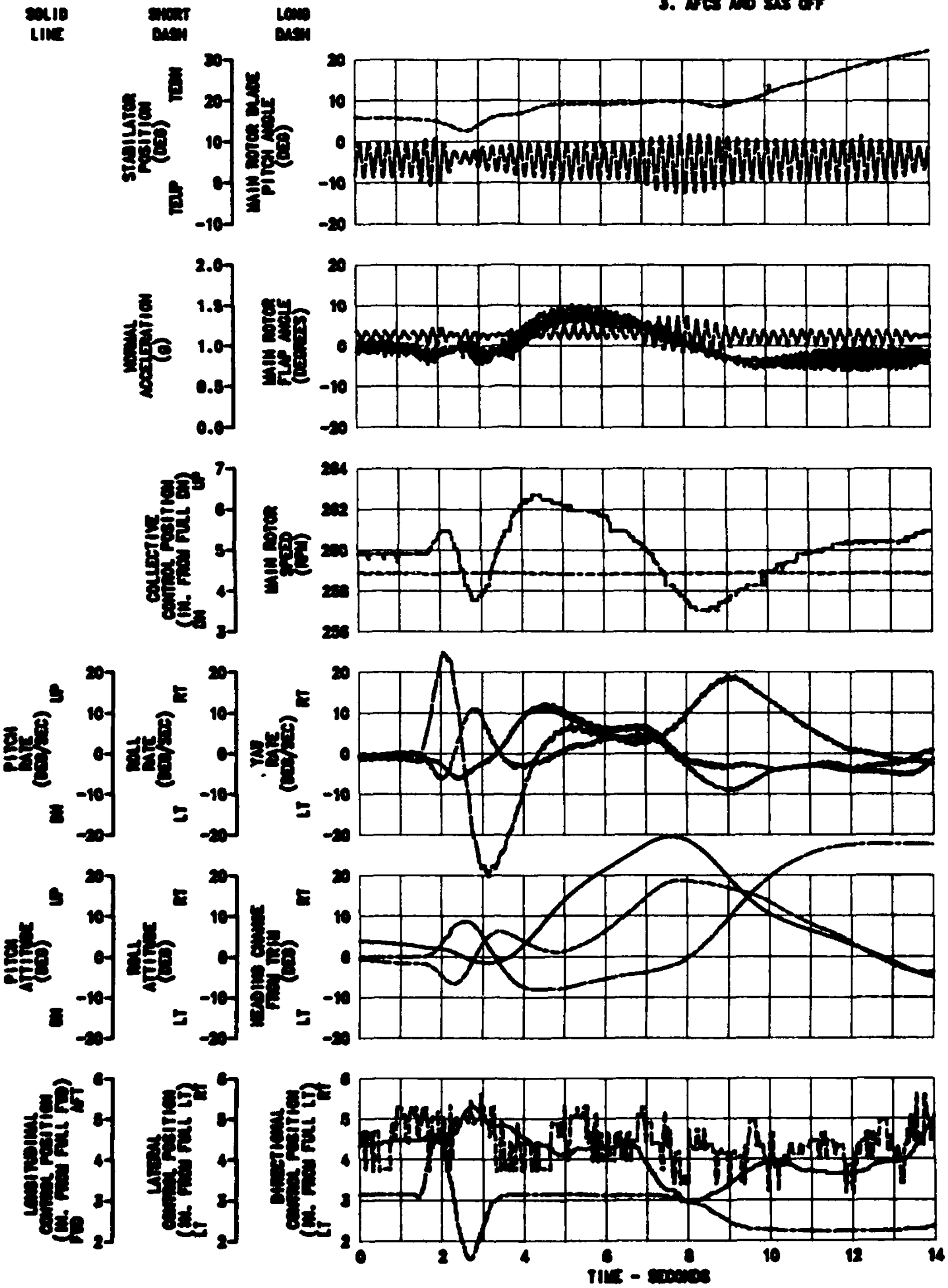


FIGURE E-37
DYNAMIC STABILITY
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
15640	350.9 (AFT)	6170	18.0	258	68

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

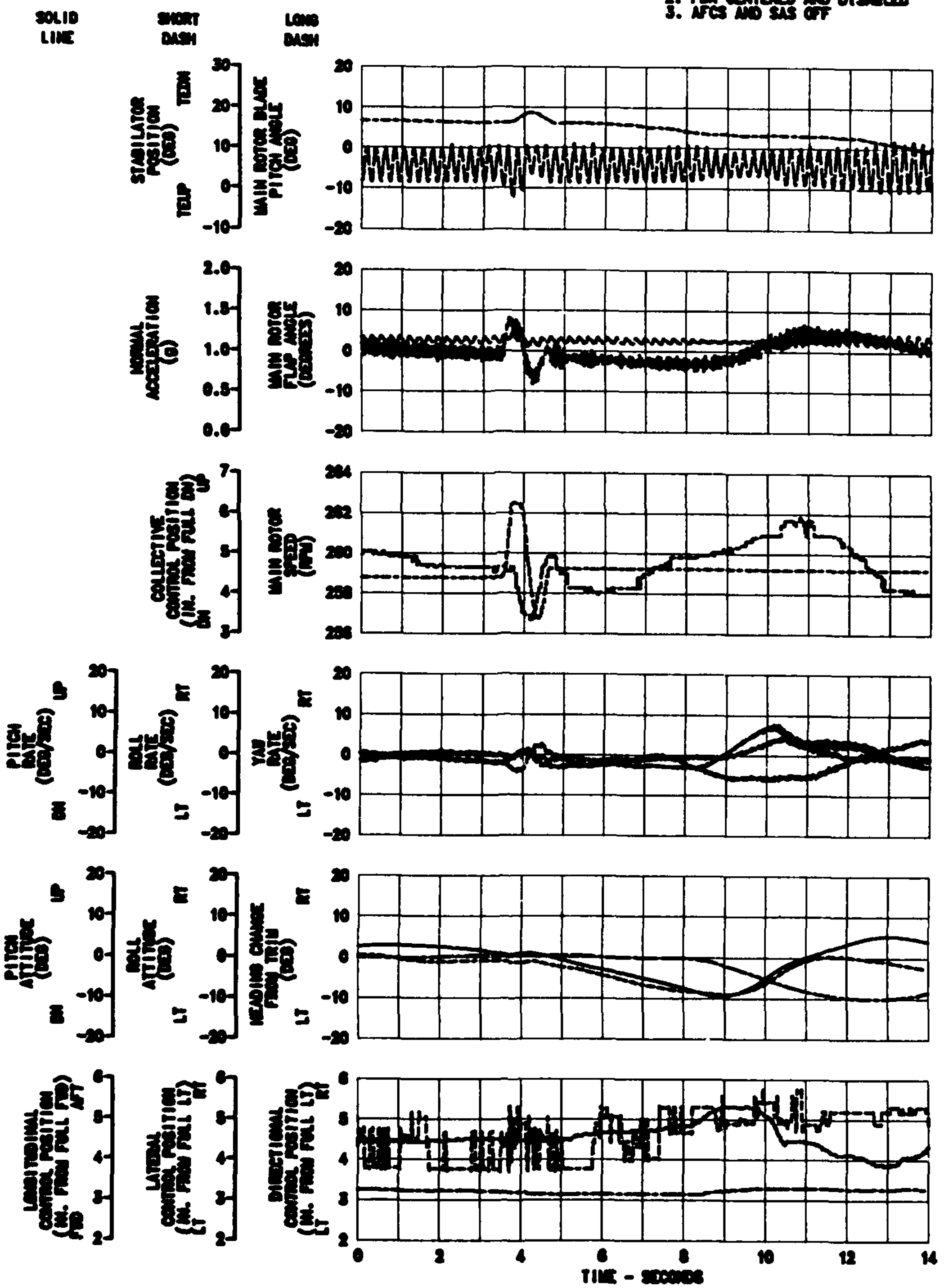


FIGURE E-38
DYNAMIC STABILITY
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
15540	358.6 (AFT)	6470	17.5	258	131

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

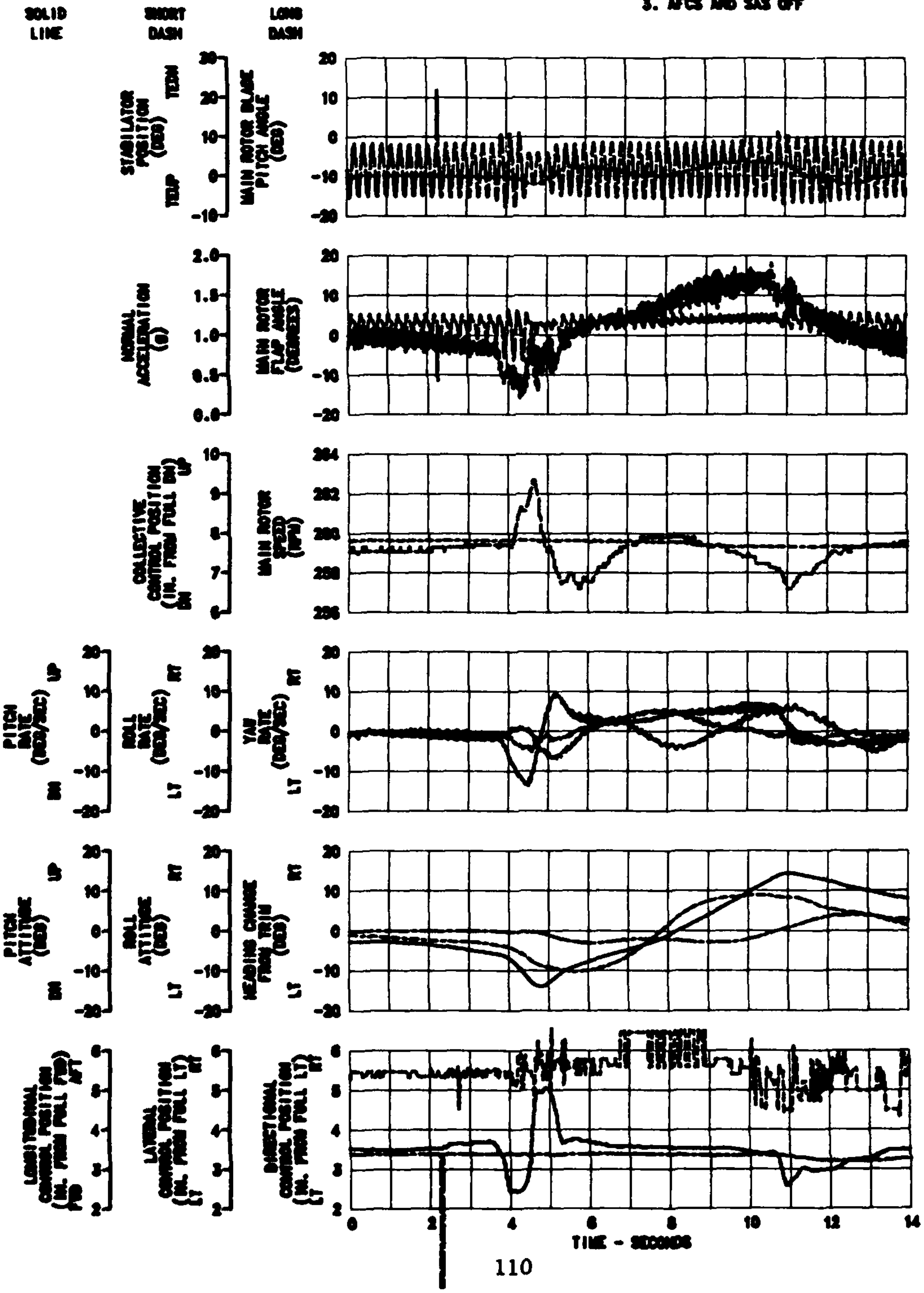


FIGURE E-30

DYNAMIC STABILITY

UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
15450	360.7 (AFT)	6680	17.0	258	134

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

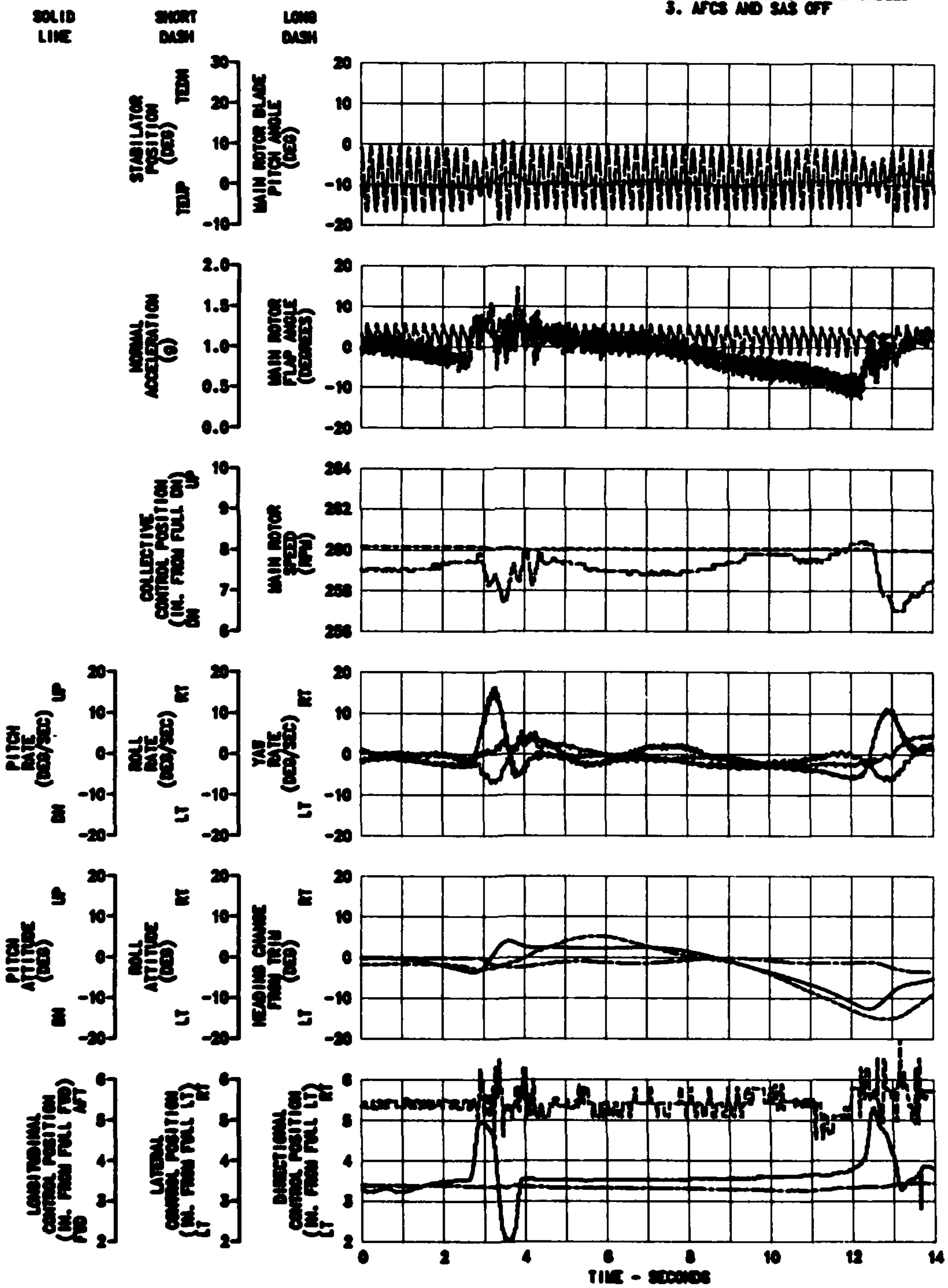


FIGURE E-40
DYNAMIC STABILITY
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
15300	350.7 (AFT)	6000	16.0	258	130

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

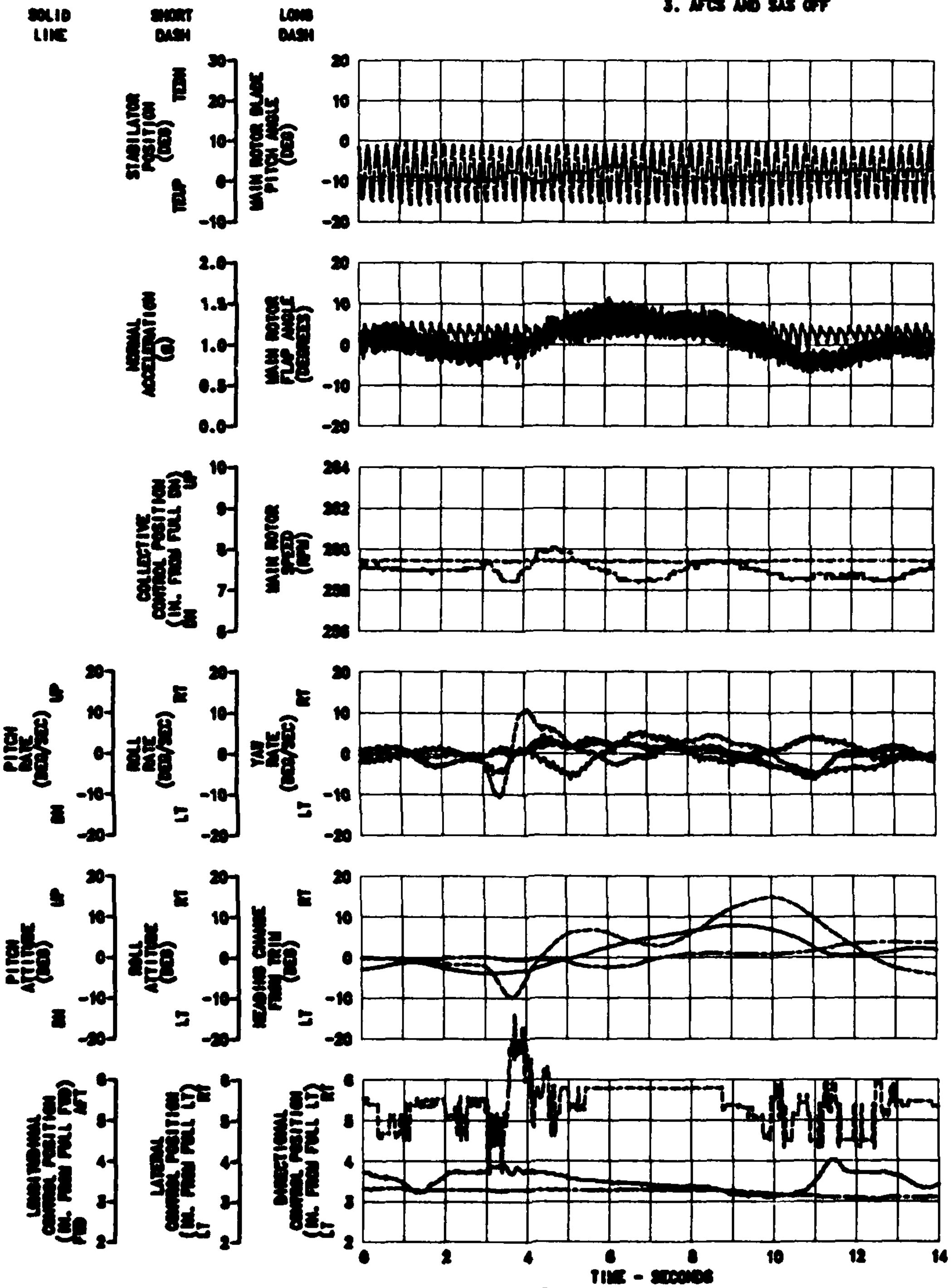


FIGURE E-41
DYNAMIC STABILITY
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
15310	350.9 (AFT)	7010	16.0	258	124

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

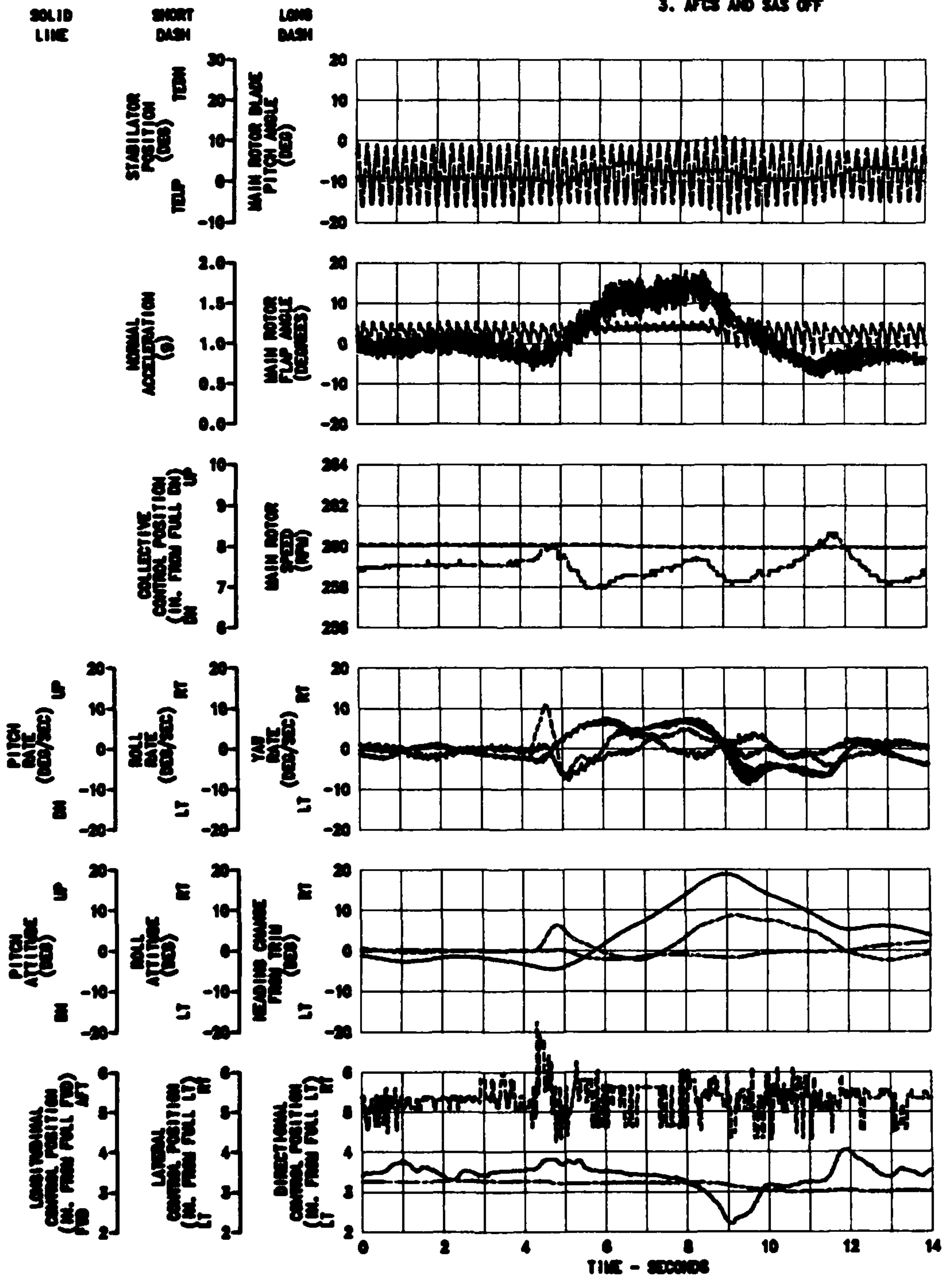


FIGURE E-42
DYNAMIC STABILITY
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
15120	358.8 (AFT)	7300	16.5	258	133

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

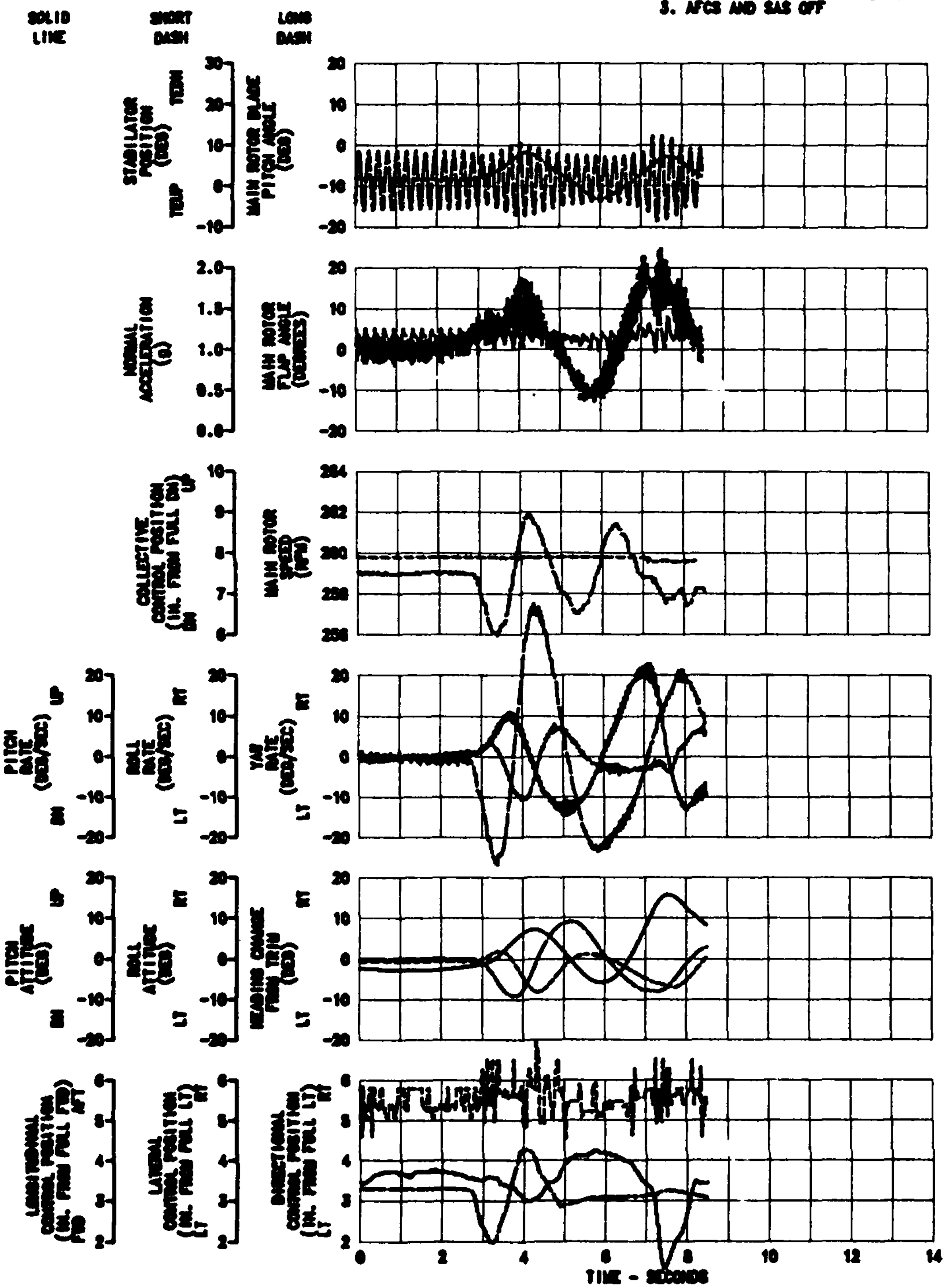


FIGURE E-43
DYNAMIC STABILITY
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
15030	350.4 (AFT)	7500	16.5	250	125

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

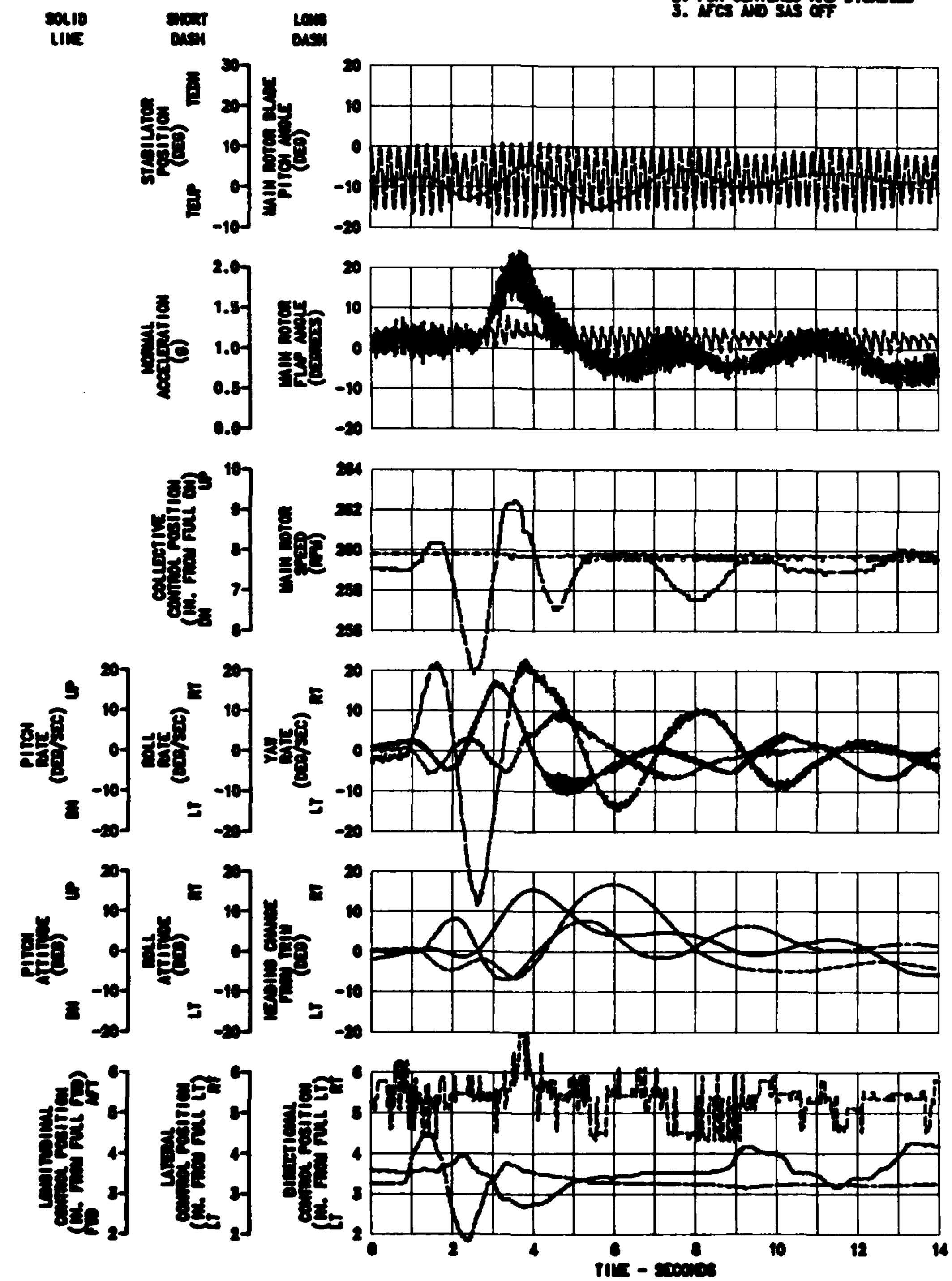


FIGURE E-44
DYNAMIC STABILITY
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
15000	358.3 (AFT)	7530	16.5	258	134

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

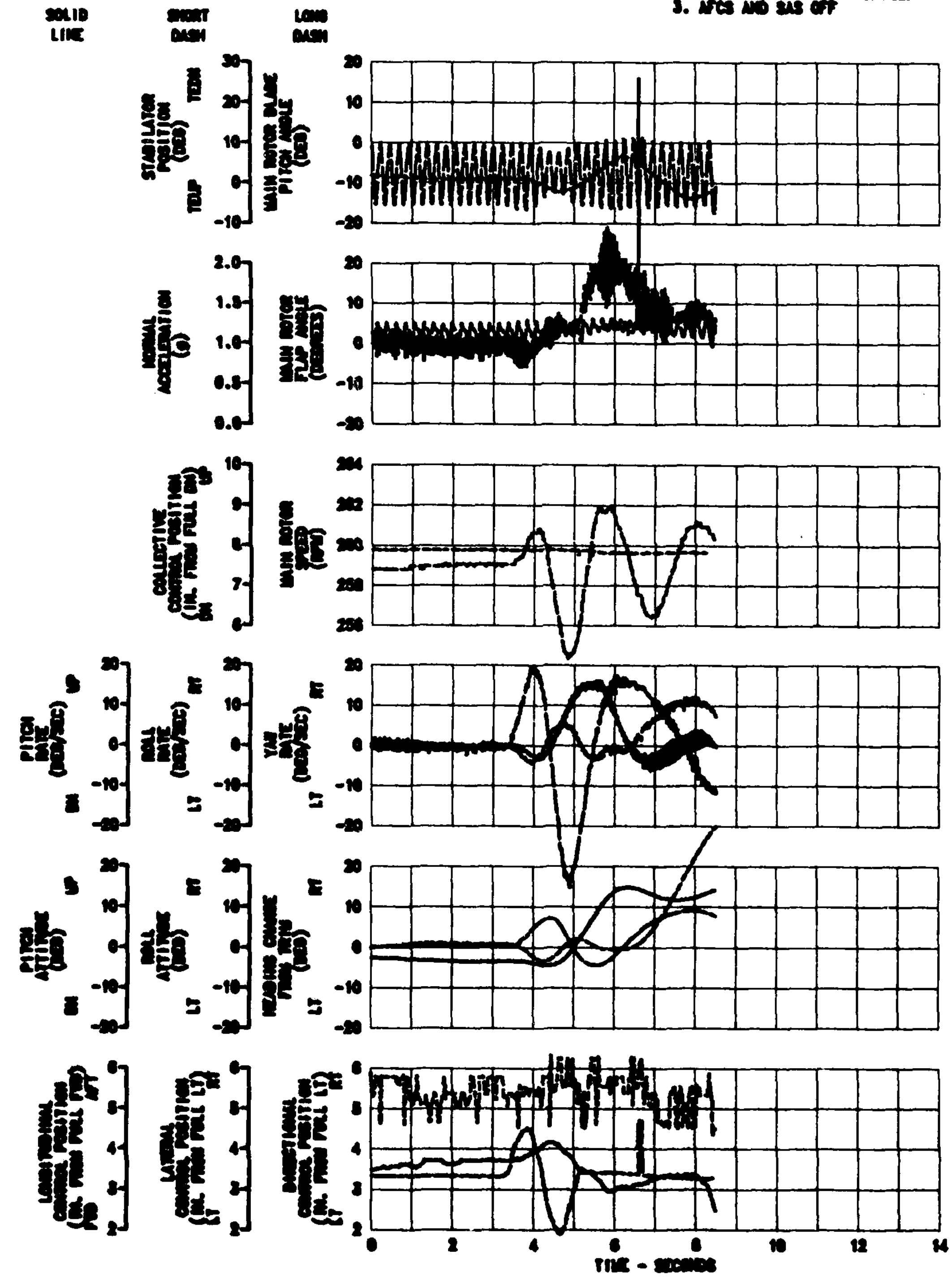


FIGURE E-45
DYNAMIC STABILITY
UH-60A USA S/N 82-23748

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	TRIM DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)
14830	350.0 (AFT)	7740	15.5	258	133

NOTES: 1. LEVEL FLIGHT TRIM CONDITION
2. PBA CENTERED AND DISABLED
3. AFCS AND SAS OFF

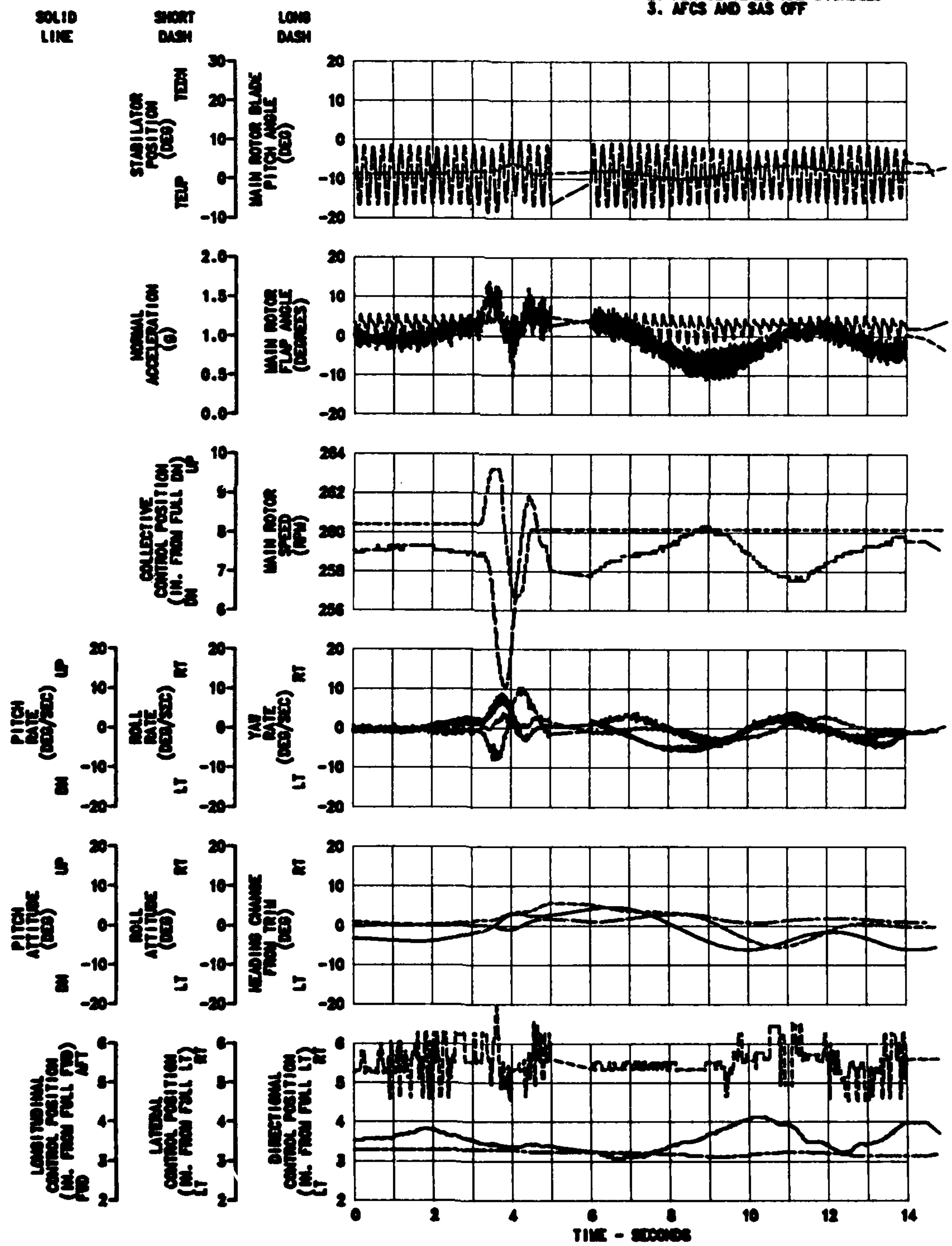


FIGURE E-46
VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

PILOT FLOOR - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15560	361.0(AFT)	5750	12.5	256.9	0.006595
○	17080	360.8(AFT)	6930	14.0	257.5	0.007465
△	19040	360.5(AFT)	6900	15.5	258.5	0.008252

NOTE FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

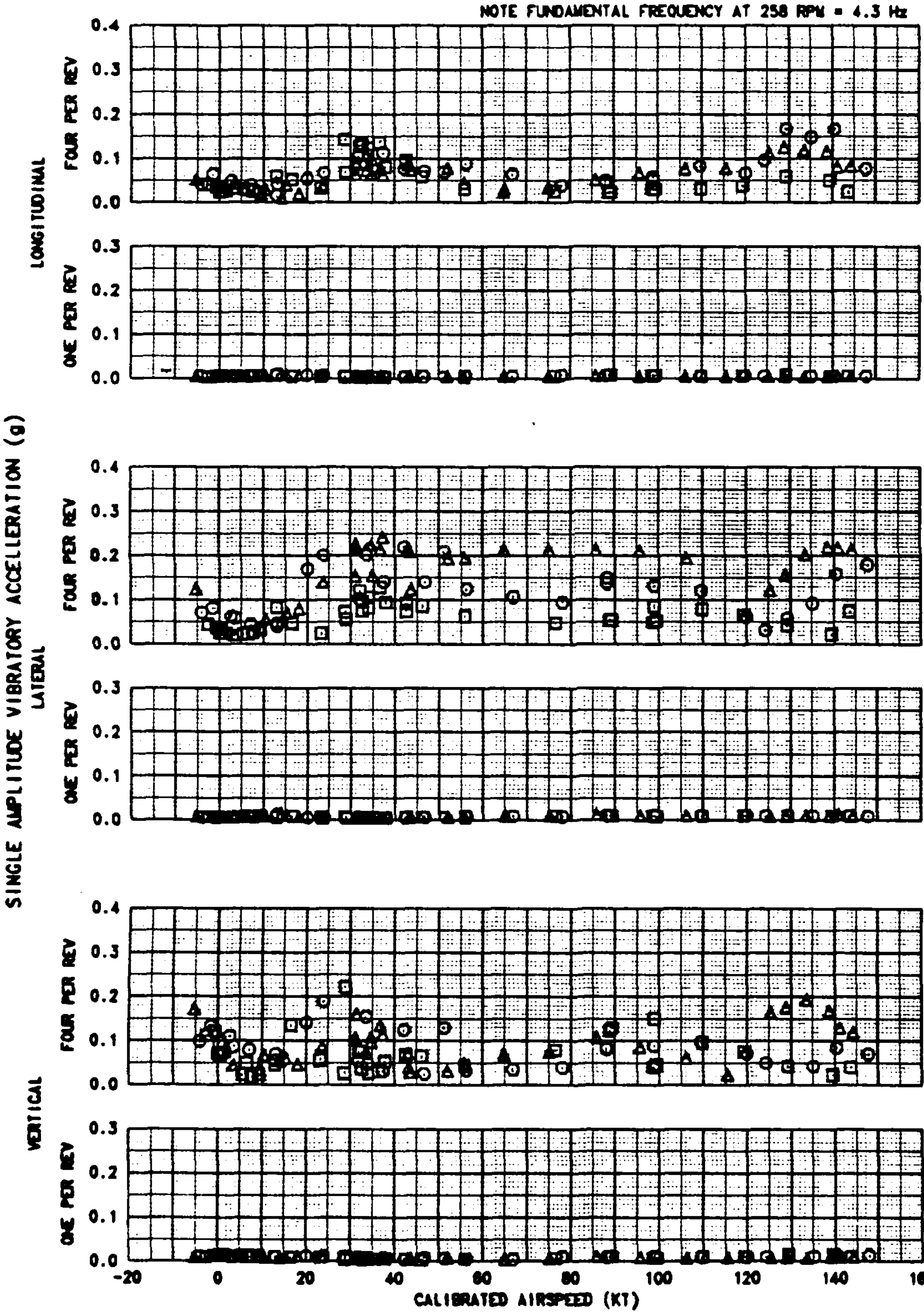


FIGURE E-47
VIBRATION CHARACTERISTICS IN CLIMBS AND POWERED DESCENTS
UH-60A USA S/N 82-23748

PILOT FLOOR - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	6960	13.0	257.3	0.006619
○	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5160	7.0	254.8	0.008252

NOTES: 1. SHADED SYMBOL DENOTES LEVEL FLIGHT
2. DATA OBTAINED USING INTERMEDIATE RATED POWER
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

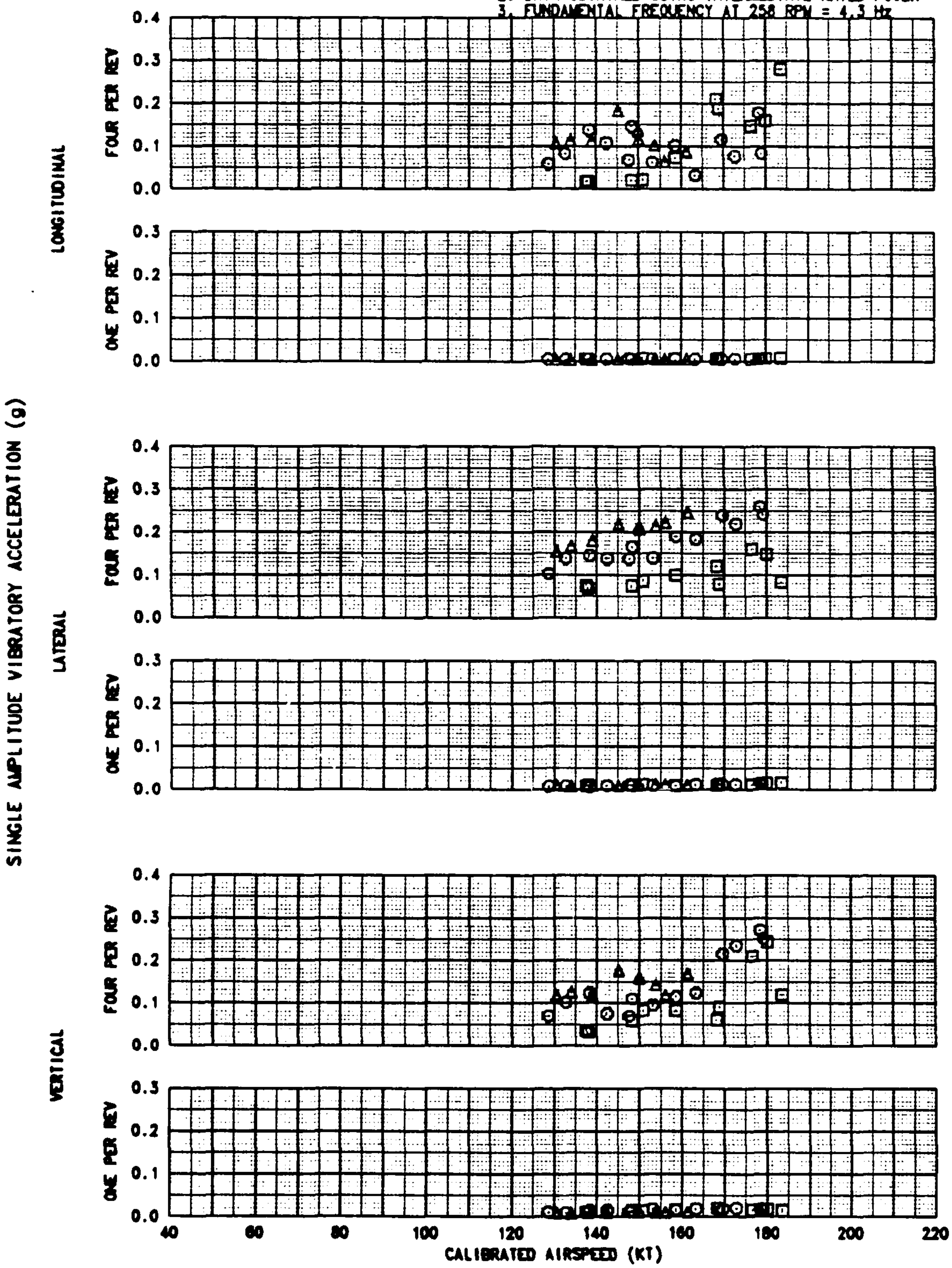


FIGURE E-48
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 122 KCAS
UH-60A USA S/N 82-23748

PILOT FLOOR - STATION FS 253.0 BL 31.0 RT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊡	15540	359.9 (AFT)	6160	14.0	258.2	0.006600
⊙	16140	360.7 (AFT)	8130	8.0	254.7	0.007486
△	17790	360.6 (AFT)	7870	8.5	255.1	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

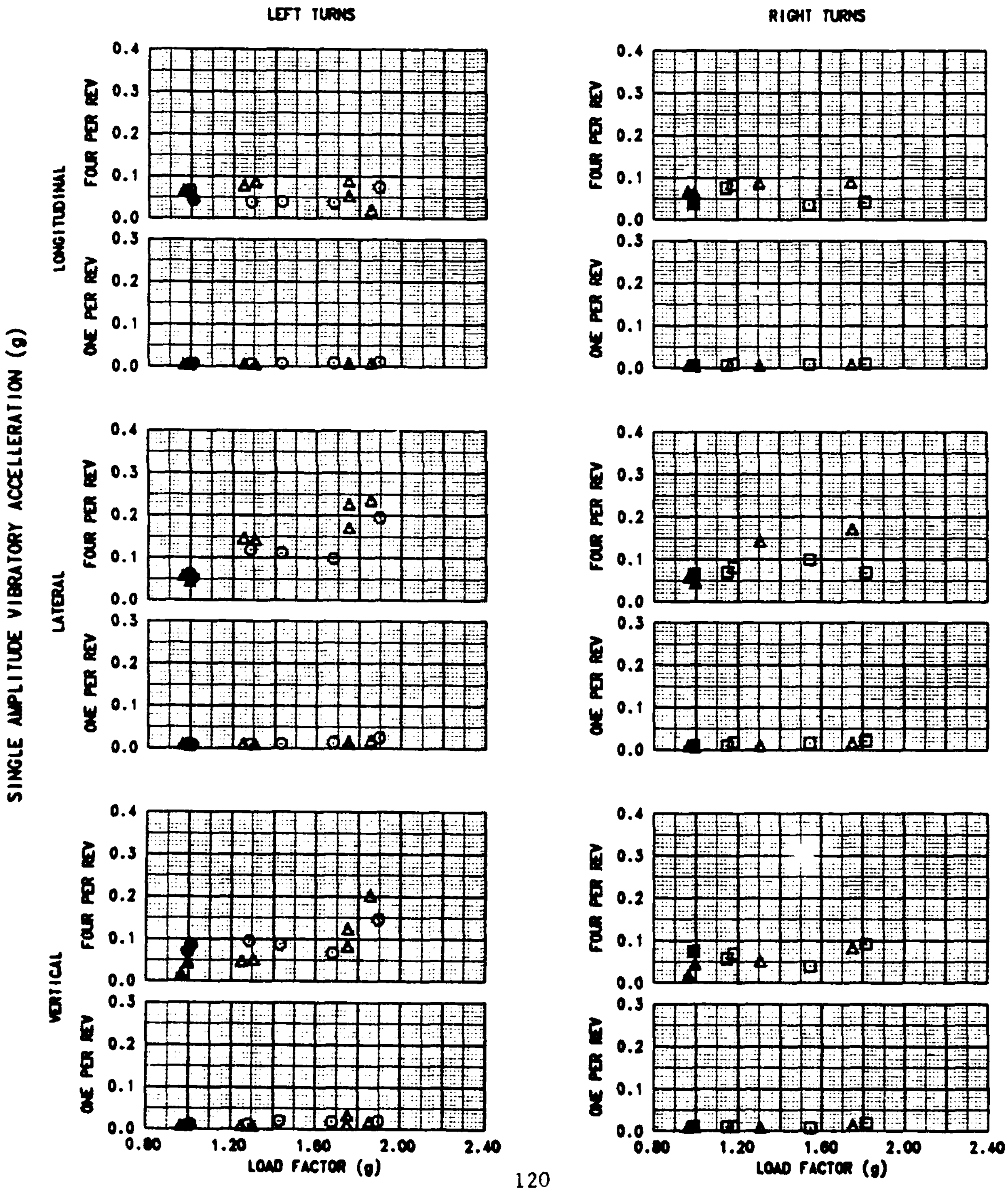


FIGURE E-49
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 140 KCAS
UH-60A USA S/N 82-23748

PILOT FLOOR - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15700	361.1 (AFT)	8850	6.0	254.5	0.007458
Δ	17570	360.7 (AFT)	8000	3.0	252.6	0.008251

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

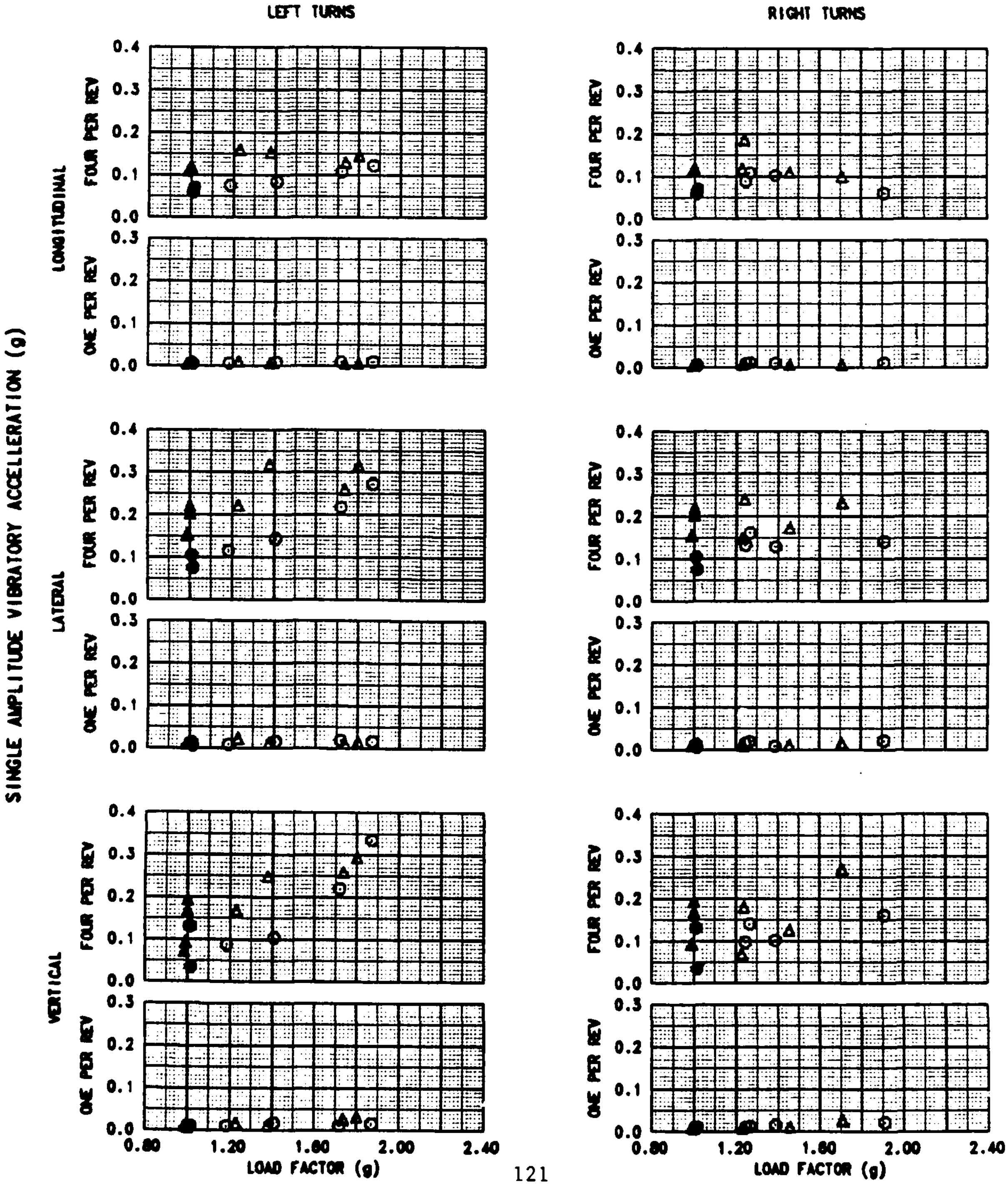


FIGURE E-50

VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 150 KCAS

UH-60A USA S/N 82-23748

PILOT FLOOR - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15610	361.2 (AFT)	8820	6.5	254.2	0.007426
△	17200	360.7 (AFT)	8380	1.0	251.1	0.008271

NOTES:
1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

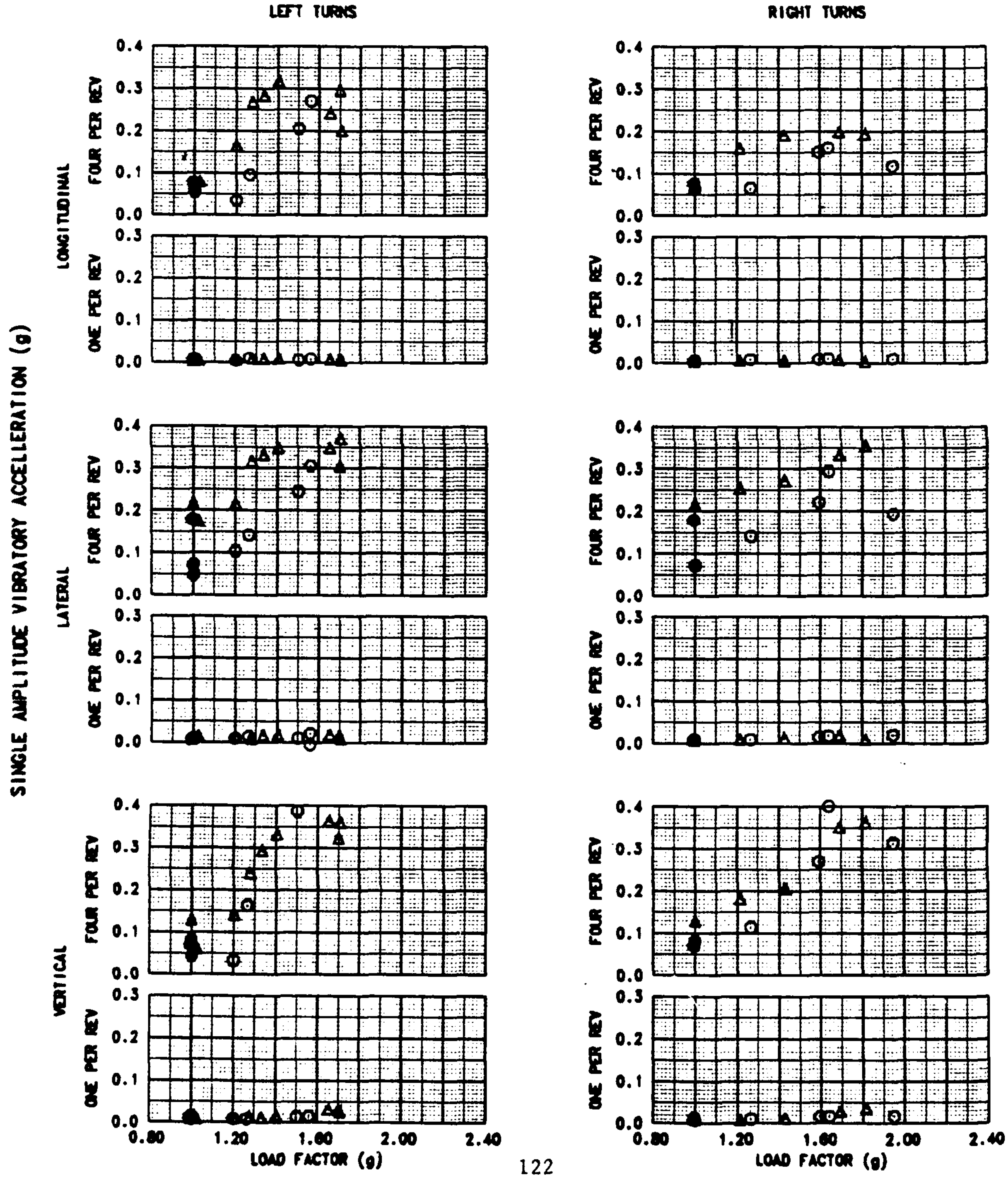


FIGURE E-51

VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 160 KCAS

UH-60A USA S/N 82-23748

PILOT FLOOR - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15920	360.7 (AFT)	8600	8.0	255.5	0.007451
△	17100	360.8 (AFT)	9080	4.5	253.0	0.008279

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

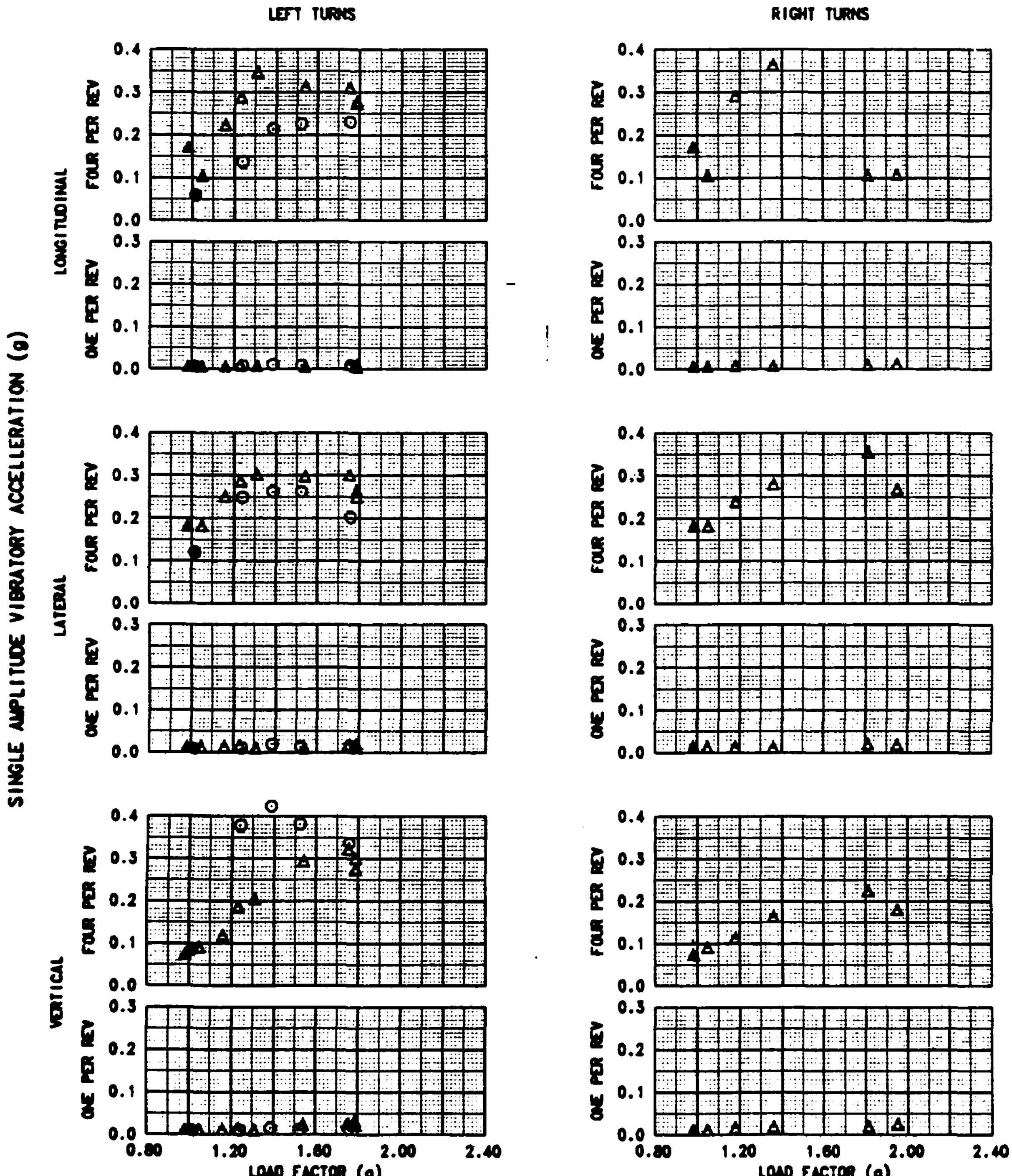


FIGURE E-52
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

PILOT FLOOR - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15400	361.5 (AFT)	9040	6.6	253.6	0.007386
Δ	17280	361.6 (AFT)	9130	9.0	254.8	0.008260

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

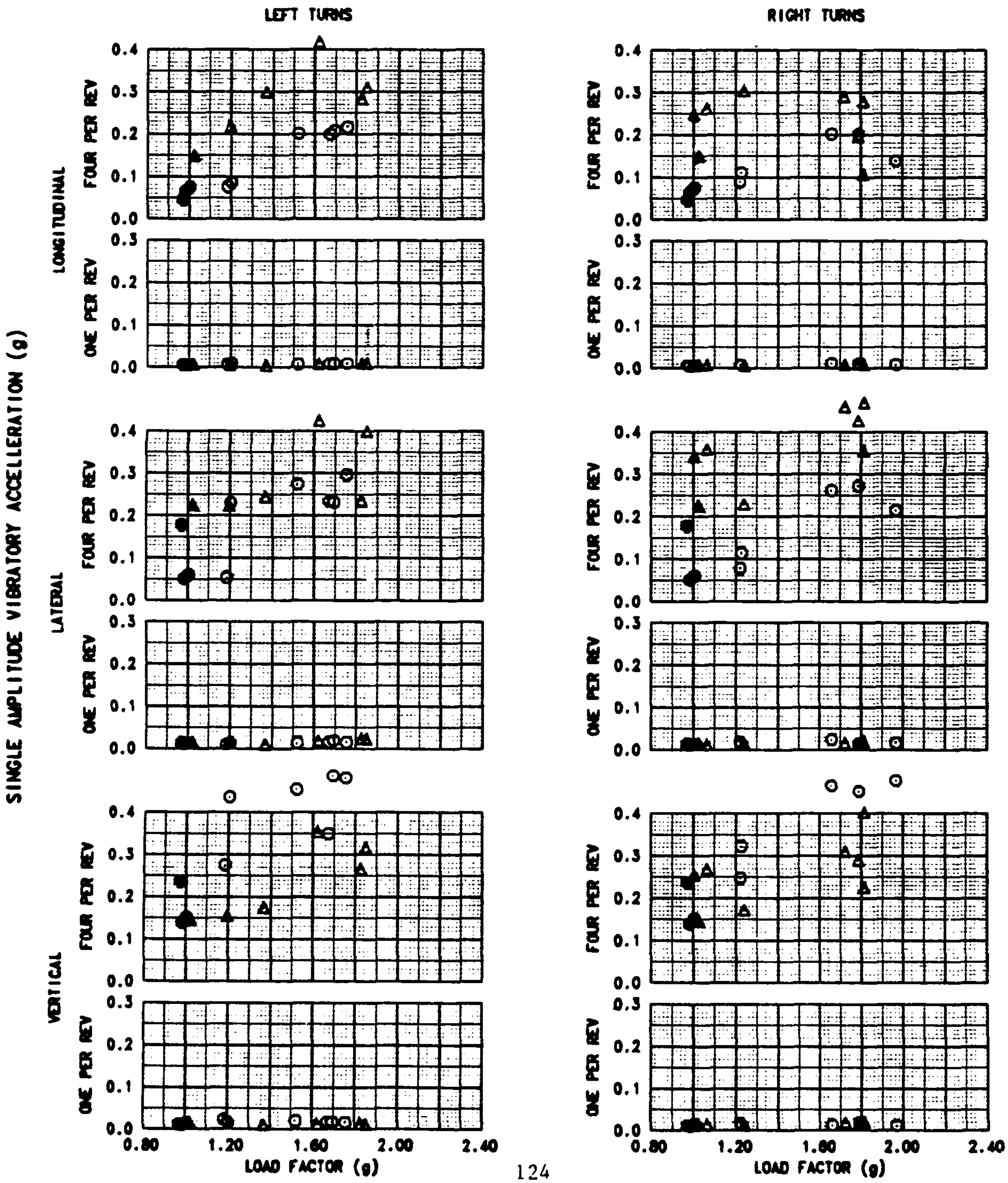


FIGURE E-53
VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

COPILOT FLOOR - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15560	361.0(AFT)	5750	12.5	256.9	0.006595
○	17080	360.8(AFT)	6930	14.0	257.5	0.007465
△	19040	360.5(AFT)	6900	15.5	258.5	0.008252

NOTE: FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

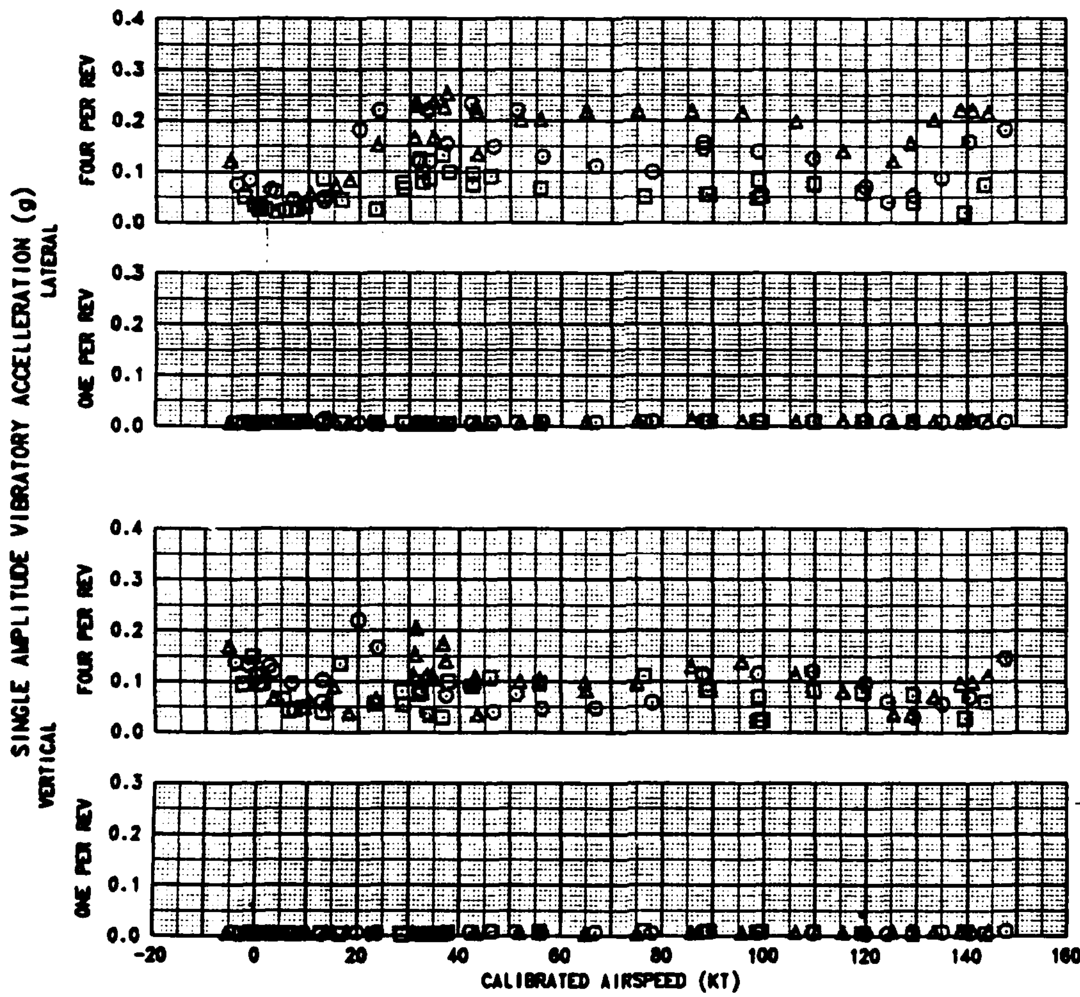


FIGURE E-54
VIBRATION CHARACTERISTICS IN CLIMBS AND POWERED DESCENTS
UH-60A USA S/N 82-23748

PILOT FLOOR - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	257.3	0.006619
⊙	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5180	7.0	254.8	0.008252

NOTES: 1. SHADED SYMBOL DENOTES LEVEL FLIGHT
2. DATA OBTAINED USING INTERMEDIATE RATED POWER
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

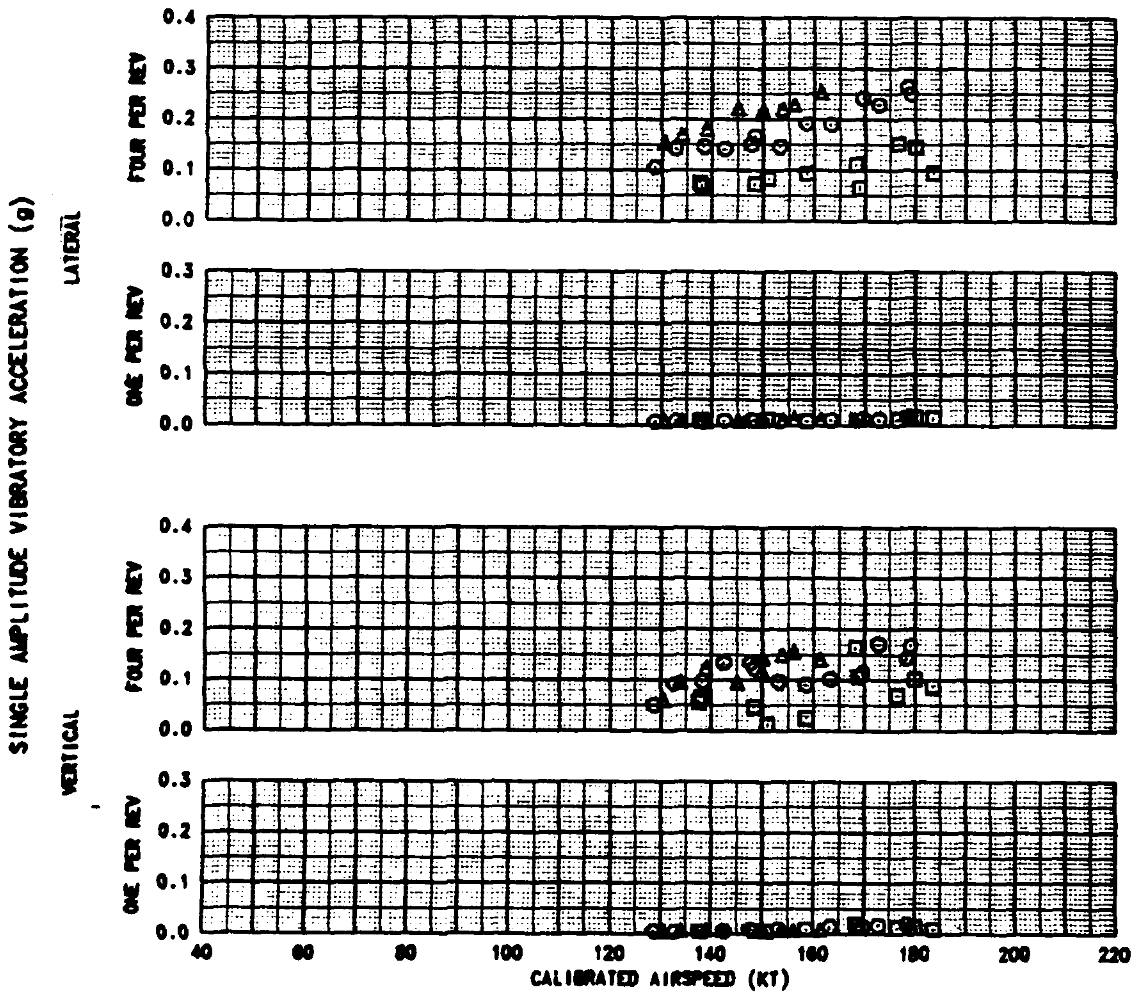


FIGURE E-55
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 122 KCAS
UH-60A USA S/N 82-23748

COPILOT FLOOR - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15540	359.9 (AFT)	6160	14.0	258.2	0.006600
○	16140	360.7 (AFT)	8130	8.0	254.7	0.007486
△	17790	360.6 (AFT)	7870	8.5	255.1	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

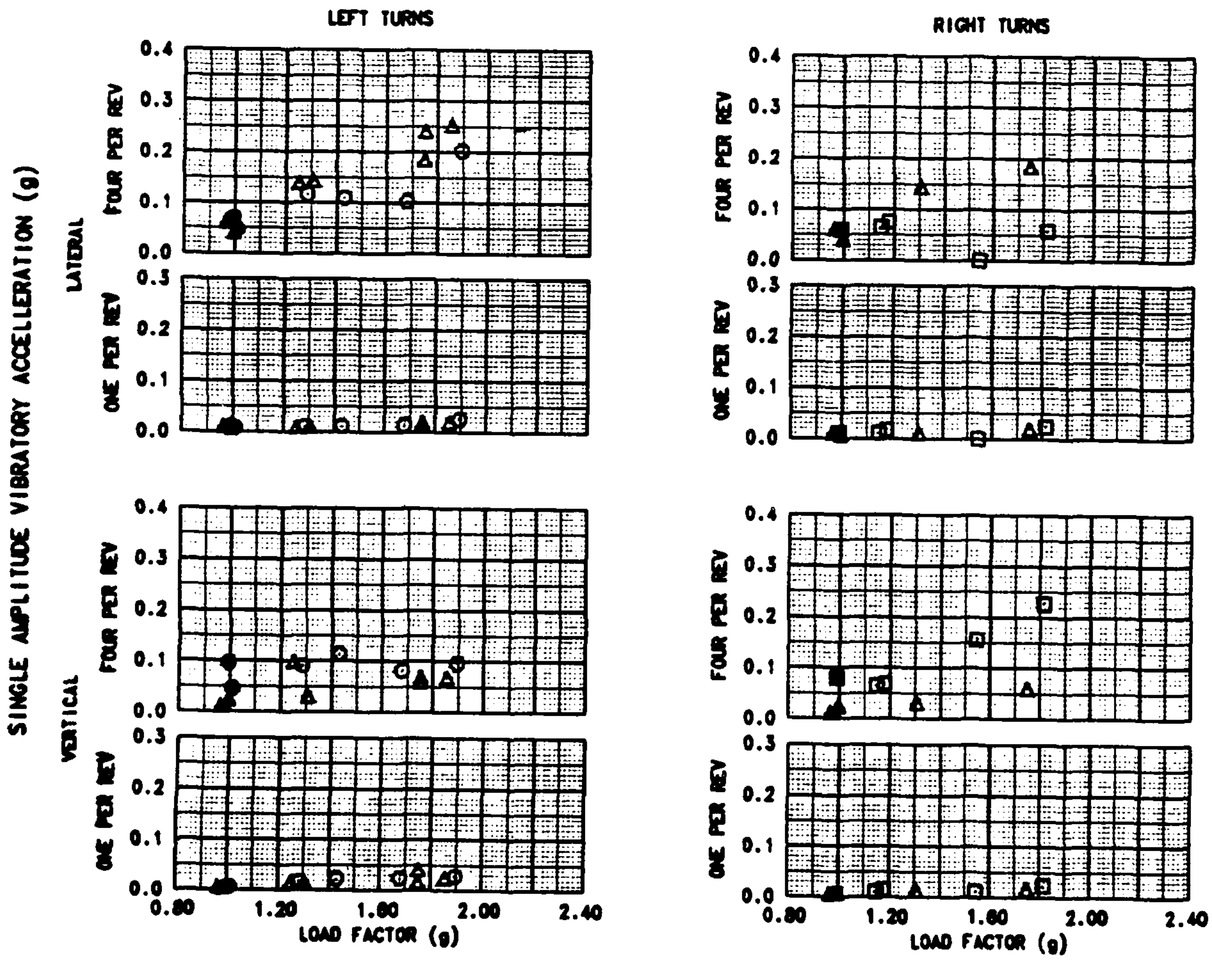


FIGURE E-56
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 140 KCAS
UH-60A USA S/N 82-23748

COPILOT FLOOR - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
O	15700	361.1 (AFT)	8850	6.0	254.5	0.007458
Δ	17570	360.7 (AFT)	8000	3.0	252.6	0.008251

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

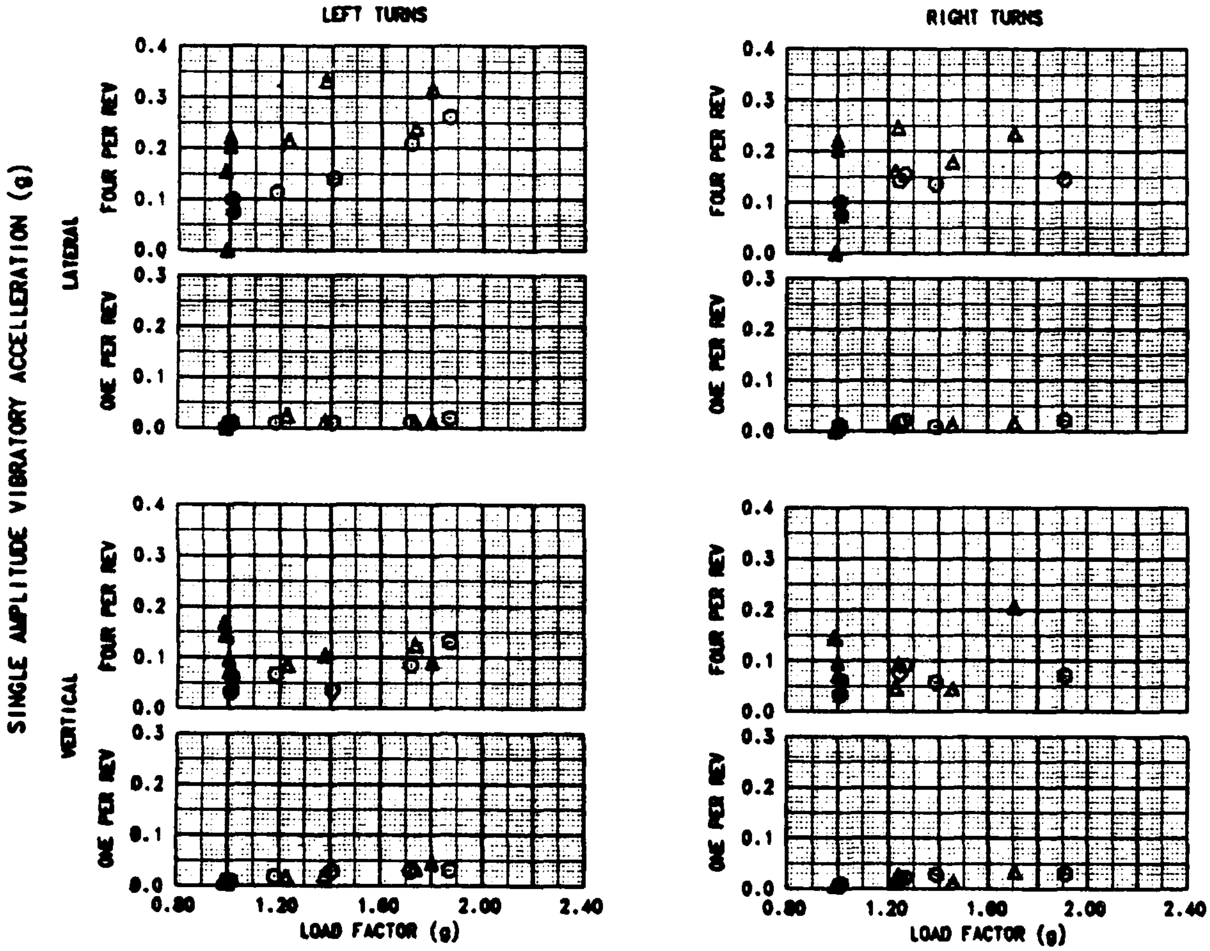


FIGURE E-57
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 150 KCAS
UH-60A USA S/N 82-23748

COPILOT FLOOR - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15610	361.2 (AFT)	8820	6.5	254.2	0.007426
△	17200	360.7 (AFT)	8380	1.0	251.1	0.008271

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

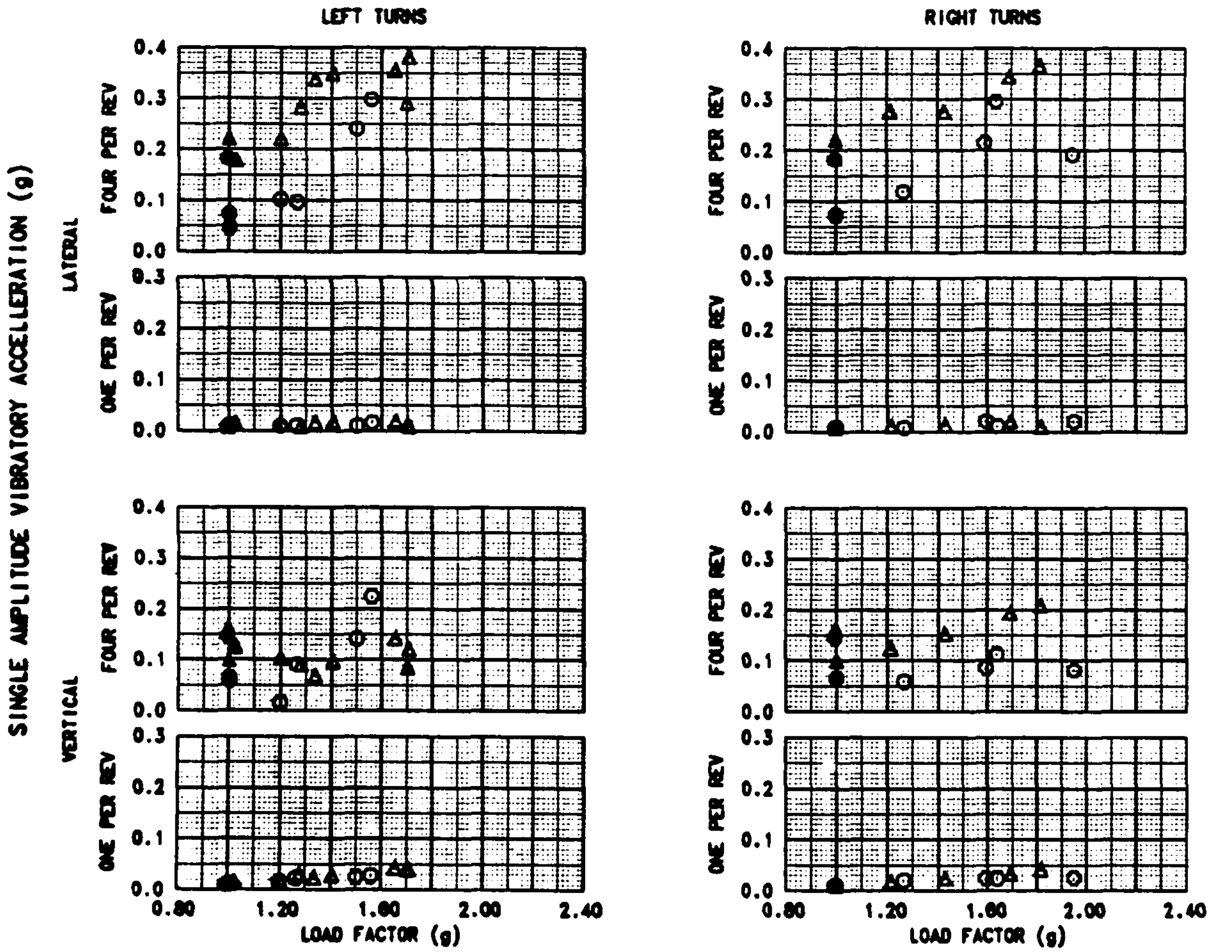


FIGURE E-58
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 160 KCAS
UH-60A USA S/N 82-23748

COPILOT FLOOR - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15920	360.7 (AFT)	8800	8.0	255.5	0.007451
Δ	17100	360.8 (AFT)	9080	4.5	253.0	0.008279

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

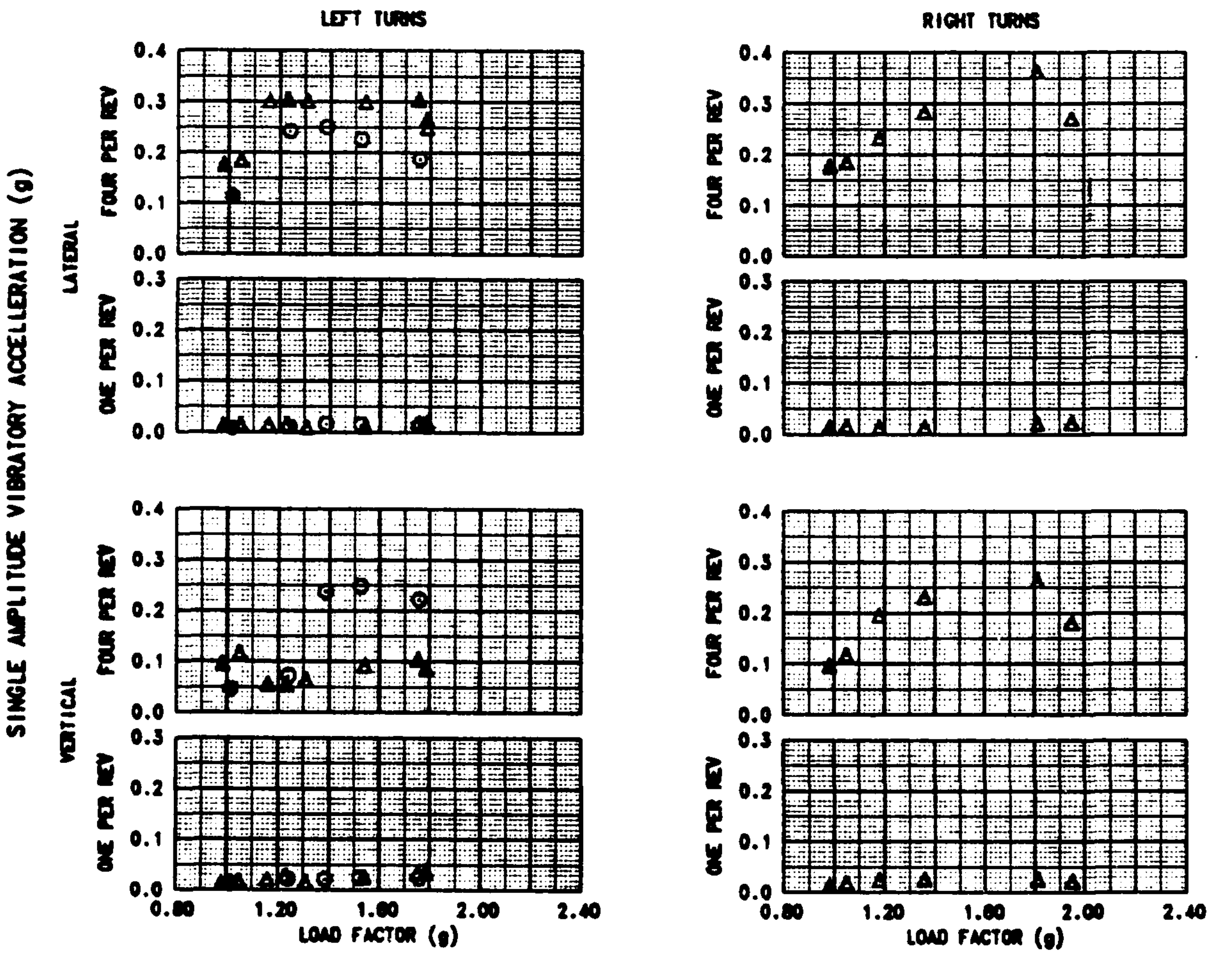


FIGURE E-59
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

COPILOT FLOOR - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15400	361.5 (AFT)	9040	6.6	253.6	0.007386
Δ	17280	361.6 (AFT)	9130	9.0	254.8	0.008260

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

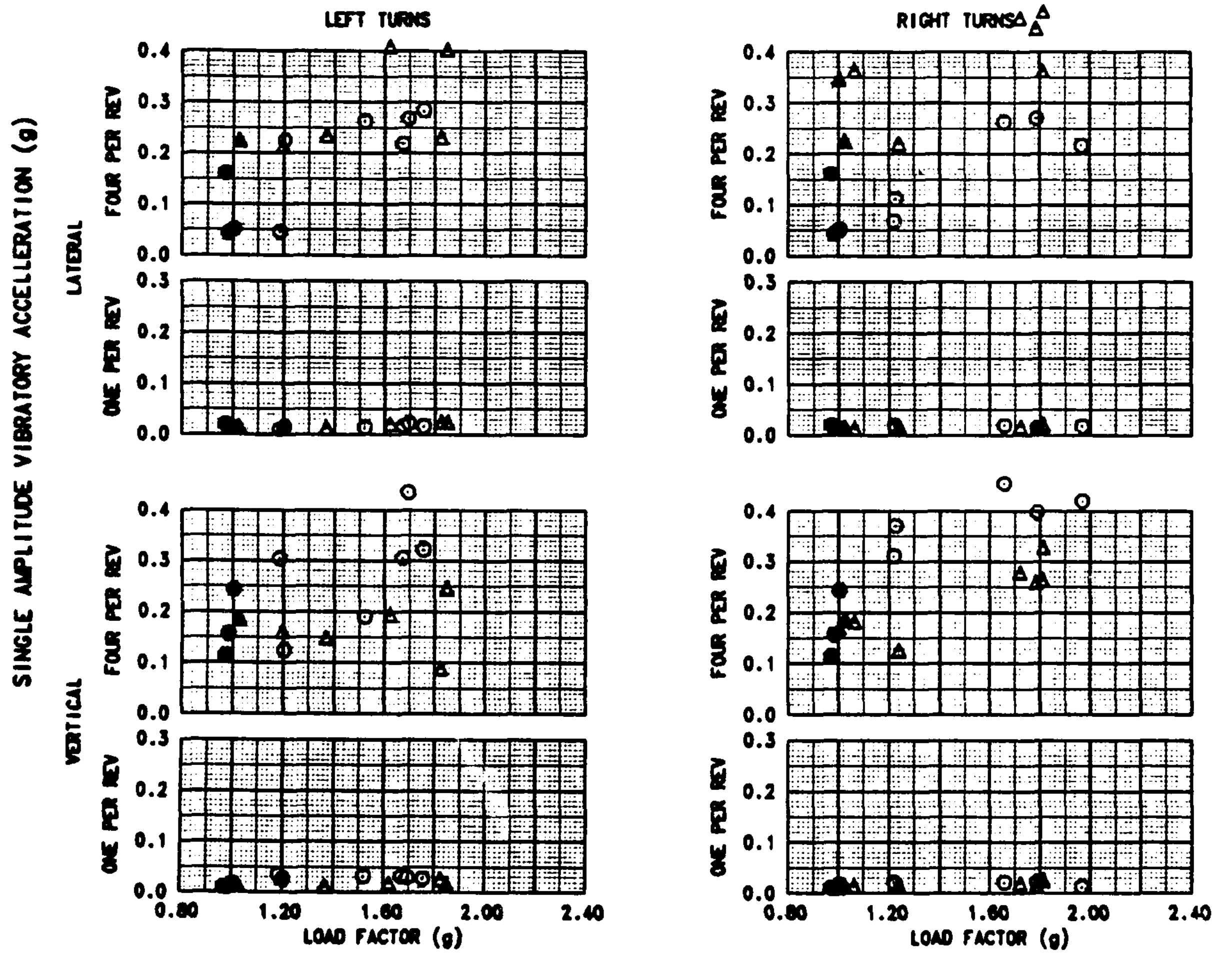


FIGURE E-60
VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

FORWARD CABIN FLOOR - STATION FS 295.0 BL 35.5 LT AND RT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15560	361.0(AFT)	5750	12.5	256.9	0.006595
○	17080	360.8(AFT)	6930	14.0	257.5	0.007465
△	19040	360.5(AFT)	6900	15.5	258.5	0.008252

NOTE: FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

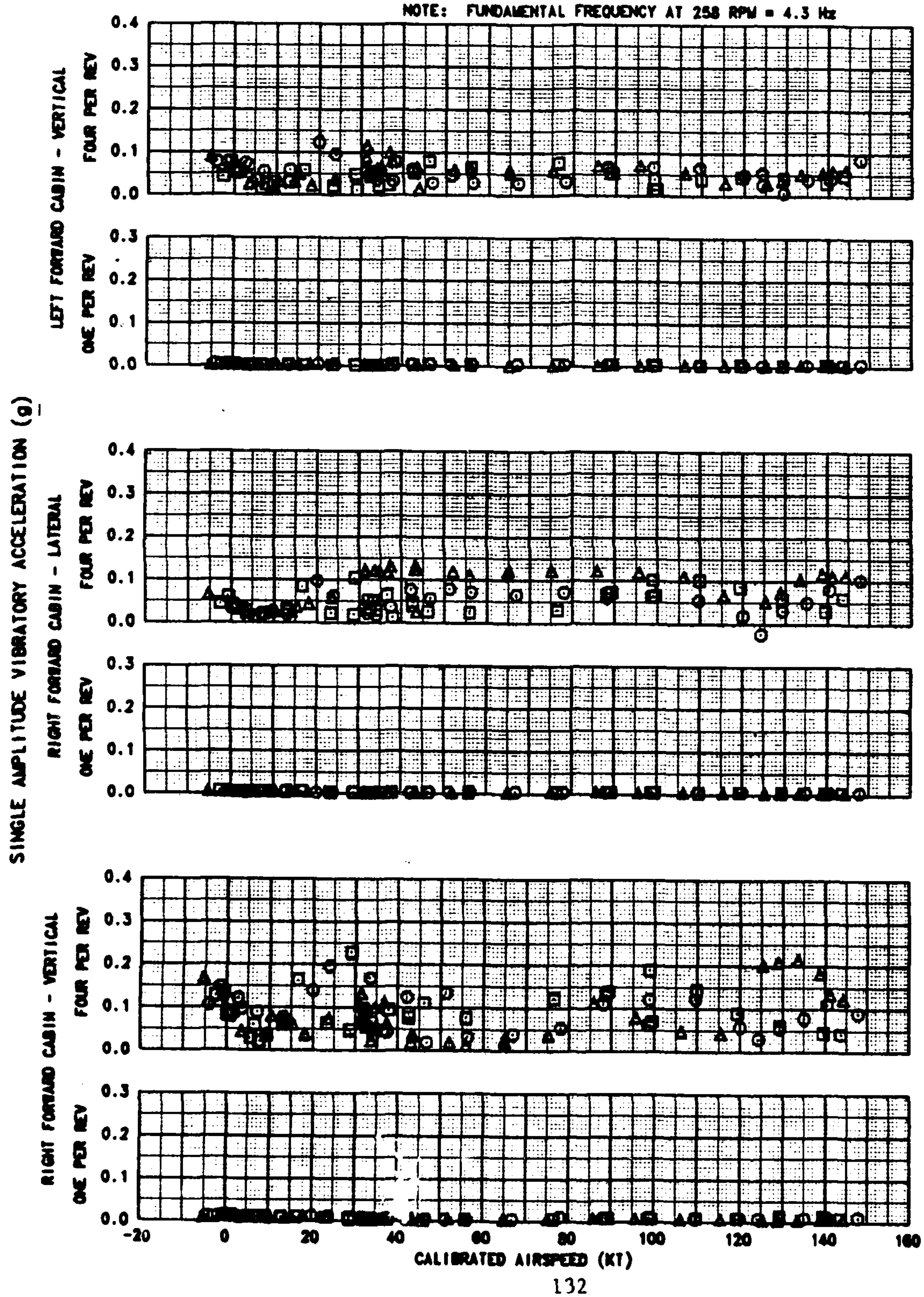


FIGURE E-61
VIBRATION CHARACTERISTICS IN CLIMBS AND POWERED DESCENTS
UH-60A USA S/N 82-23748

FORWARD CABIN FLOOR - STATION FS 295.0 BL 35.5 LT AND RT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	257.3	0.006619
⊙	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5160	7.0	254.8	0.008252

NOTES: 1. SHADED SYMBOL DENOTES LEVEL FLIGHT
2. DATA OBTAINED USING INTERMEDIATE RATED POWER
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

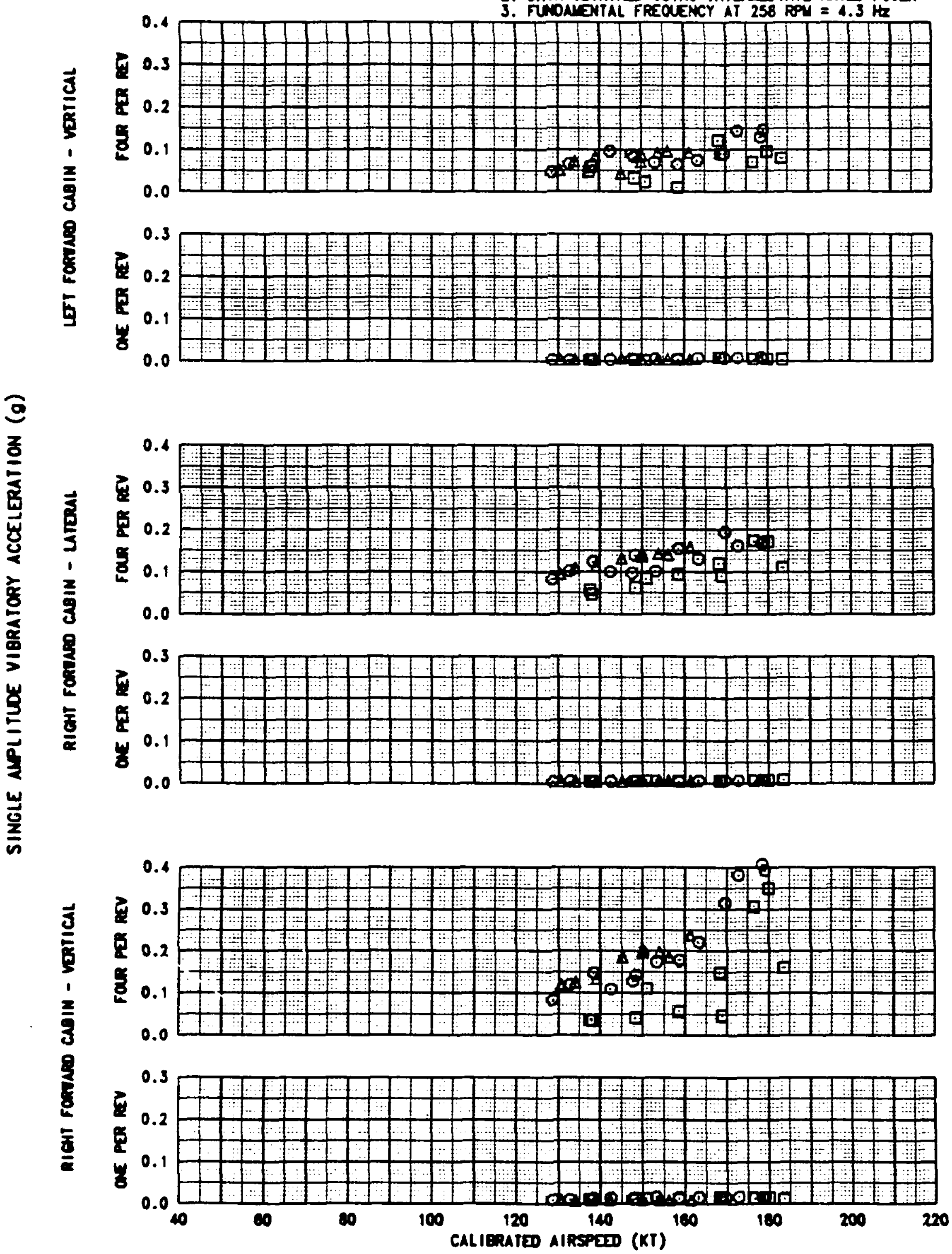


FIGURE E-62
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 122 KCAS
UH-60A USA S/N 82-23748

FORWARD CABIN FLOOR - STATION FS 295.0 BL 35.5 LT AND RT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15540	359.9 (AFT)	6160	14.0	258.2	0.006600
⊙	16140	360.7 (AFT)	8130	8.0	254.7	0.007486
△	17790	360.6 (AFT)	7870	8.5	255.1	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3Hz

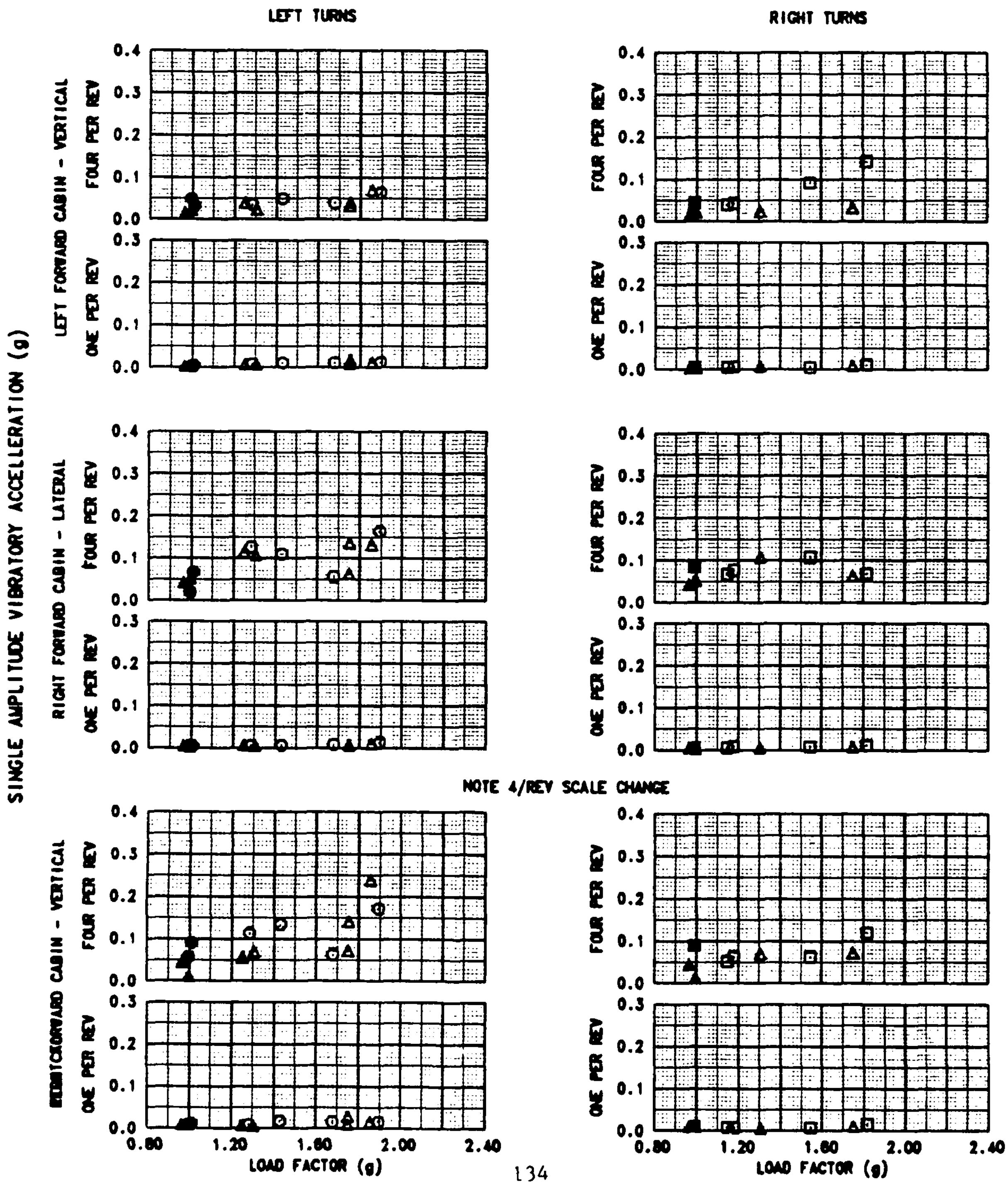


FIGURE E-63
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 140 KCAS
UH-60A USA S/N 82-23748

FORWARD CABIN FLOOR - STATION FS 295.0 BL 35.5 LT AND RT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15700	361.1 (AFT)	8850	6.0	254.5	0.007458
Δ	17570	360.7 (AFT)	8000	3.0	252.6	0.008251

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

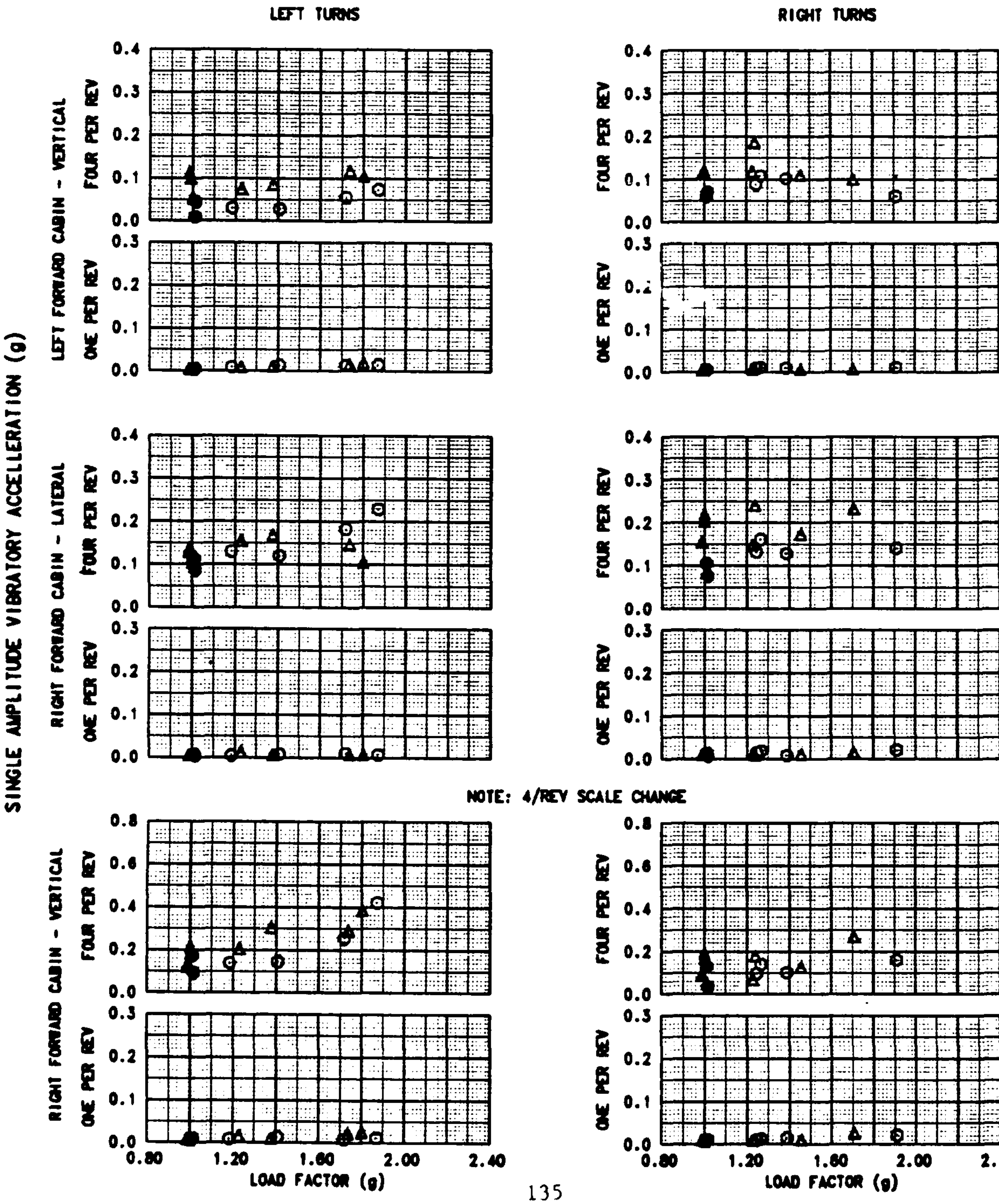


FIGURE E-64
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 150 KCAS
UH-60A USA S/N 82-23748

FORWARD CABIN FLOOR - STATION FS 295.0 BL 35.5 LT AND RT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15610	361.2 (AFT)	8820	6.5	254.2	0.007426
Δ	17200	360.7 (AFT)	8380	1.0	251.1	0.008271

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

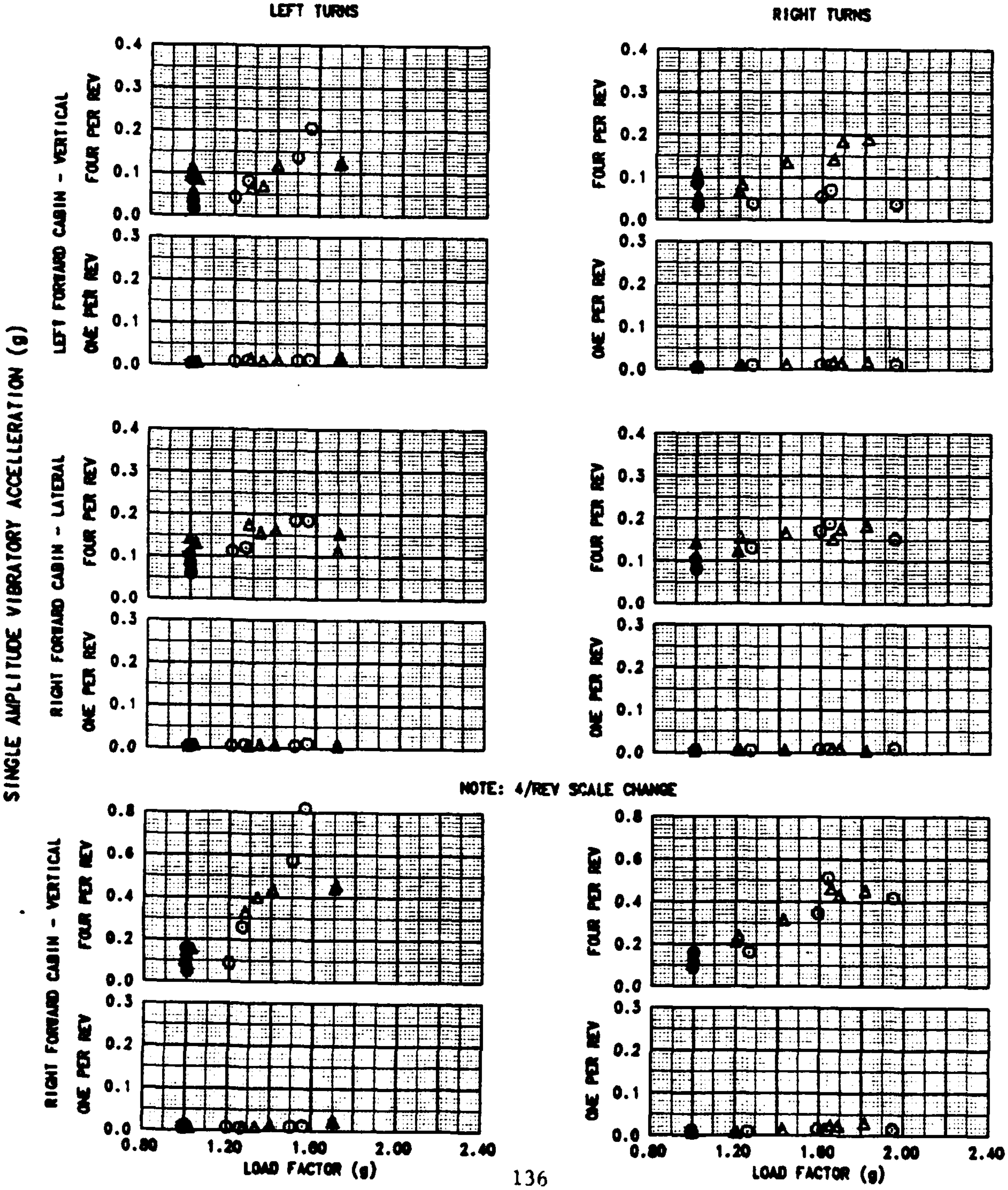


FIGURE E-65
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 160 KCAS
UH-60A USA S/N 82-23748

FORWARD CABIN FLOOR - STATION FS 295.0 BL 35.5 LT AND RT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15920	360.7 (AFT)	8600	8.0	255.5	0.007451
Δ	17100	360.8 (AFT)	9080	4.5	253.0	0.008279

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

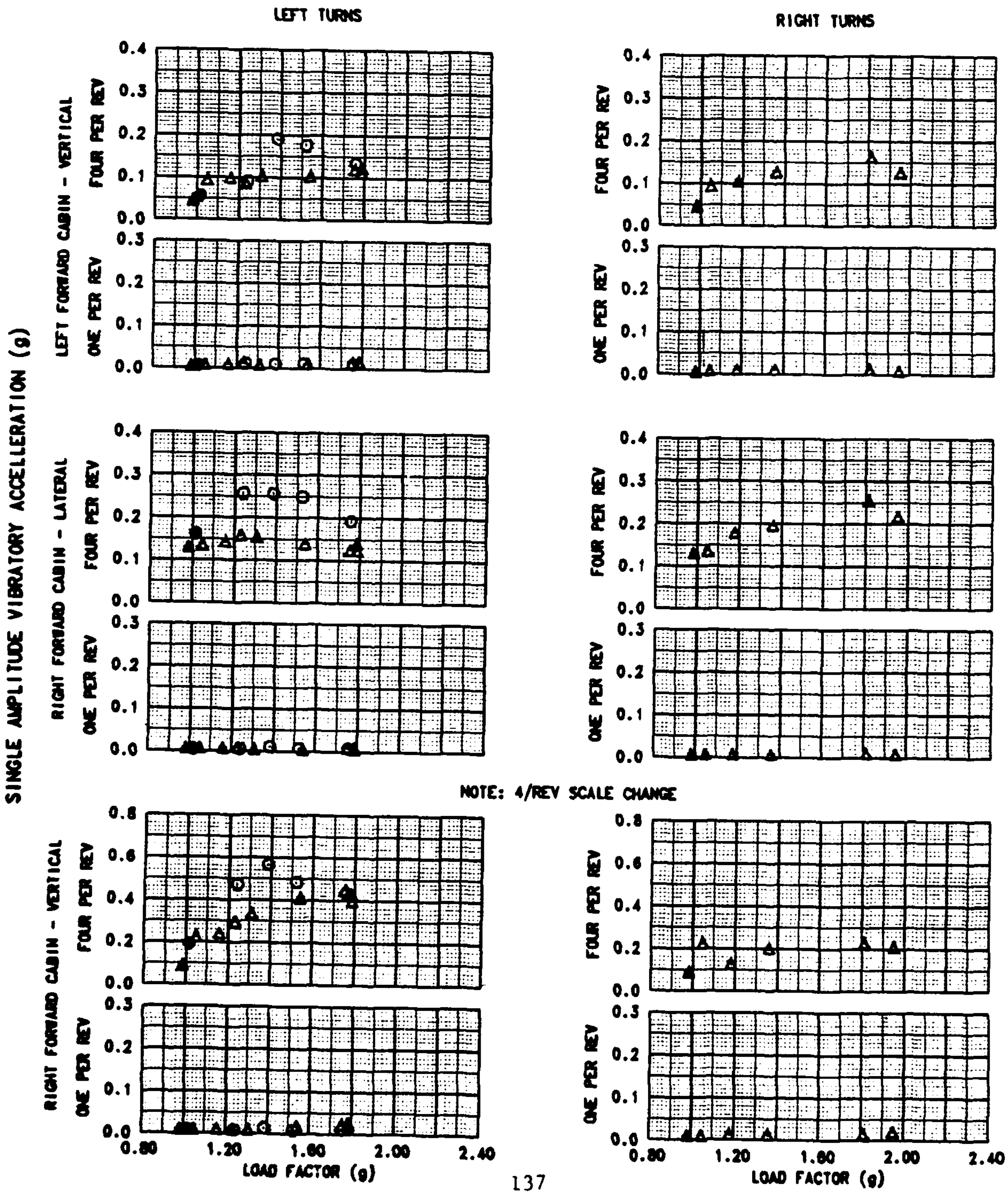


FIGURE E-66
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

FORWARD CABIN FLOOR - STATION FS 295.0 BL 35.5 LT AND RT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15400	361.5 (AFT)	9040	6.6	253.6	0.007388
△	17280	361.6 (AFT)	9130	9.0	254.8	0.008260

NOTES:
1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

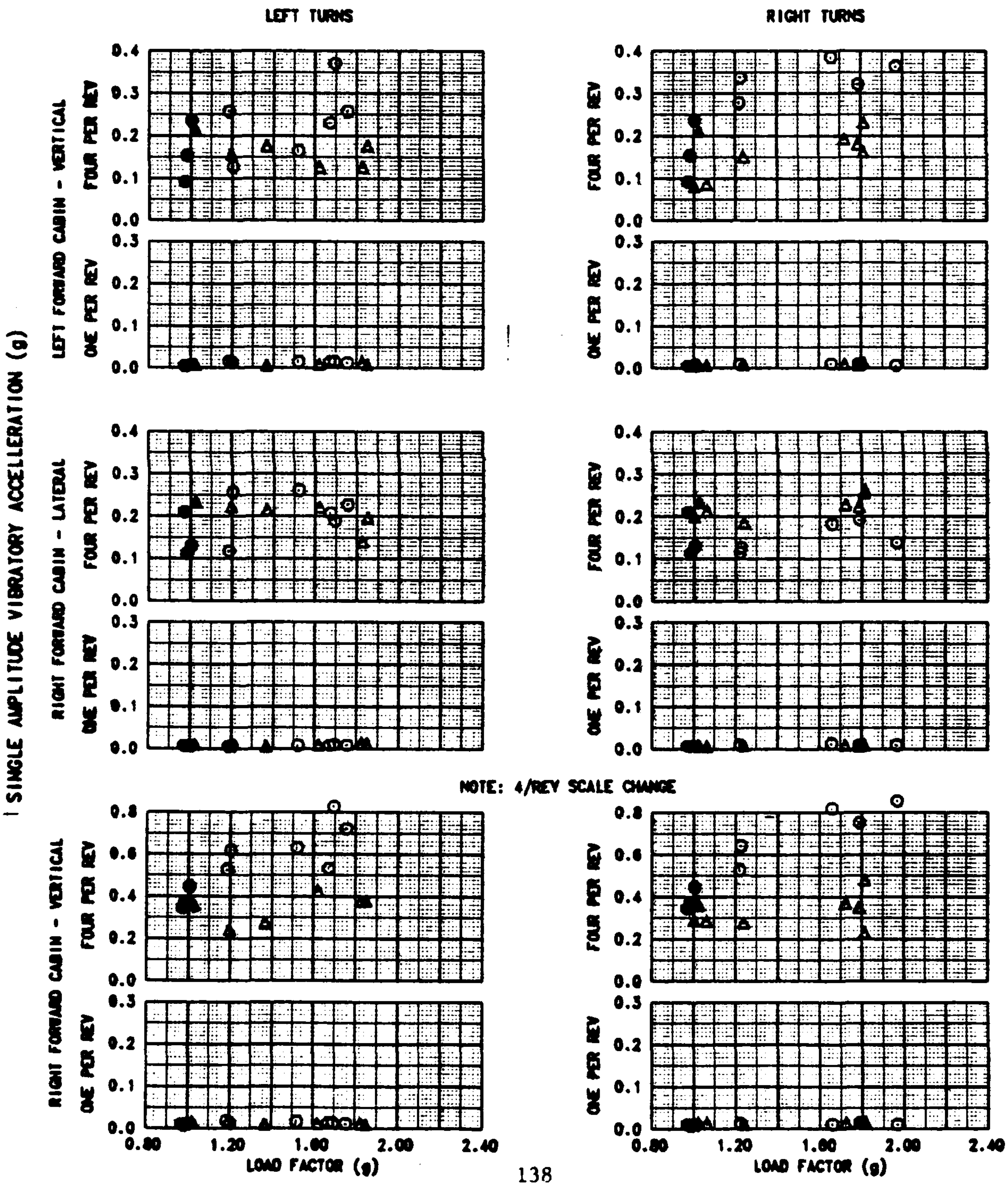


FIGURE E-67
VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

AFT CABIN FLOOR - STATION FS 398.0 BL 35.0 LT AND RT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15560	361.0(AFT)	5750	12.5	258.5	0.006595
○	17080	360.8(AFT)	6930	14.0	258.2	0.007465
△	19040	360.5(AFT)	6900	15.5	258.5	0.008252

NOTE: FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3

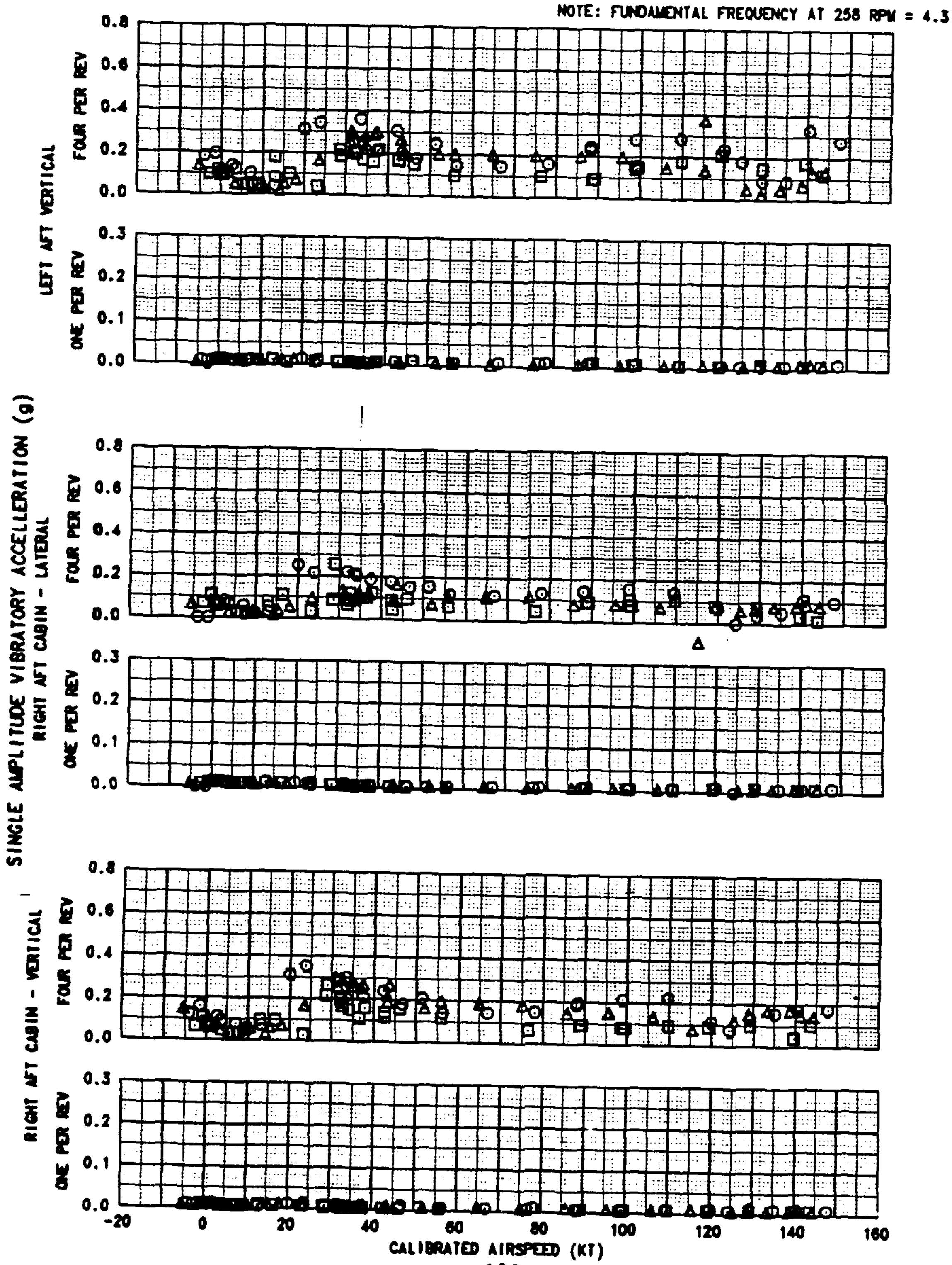


FIGURE E-68

VIBRATION CHARACTERISTICS IN CLIMBS AND POWERED DESCENTS

UH-60A USA S/N 82-23748

AFT CABIN FLOOR - STATION FS 398.0 BL 35.0 LT AND RT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	257.3	0.006819
○	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5180	7.0	254.8	0.008252

NOTES: 1. SHADED SYMBOL DENOTES LEVEL FLIGHT
2. DATA OBTAINED USING INTERMEDIATE RATED POWER
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

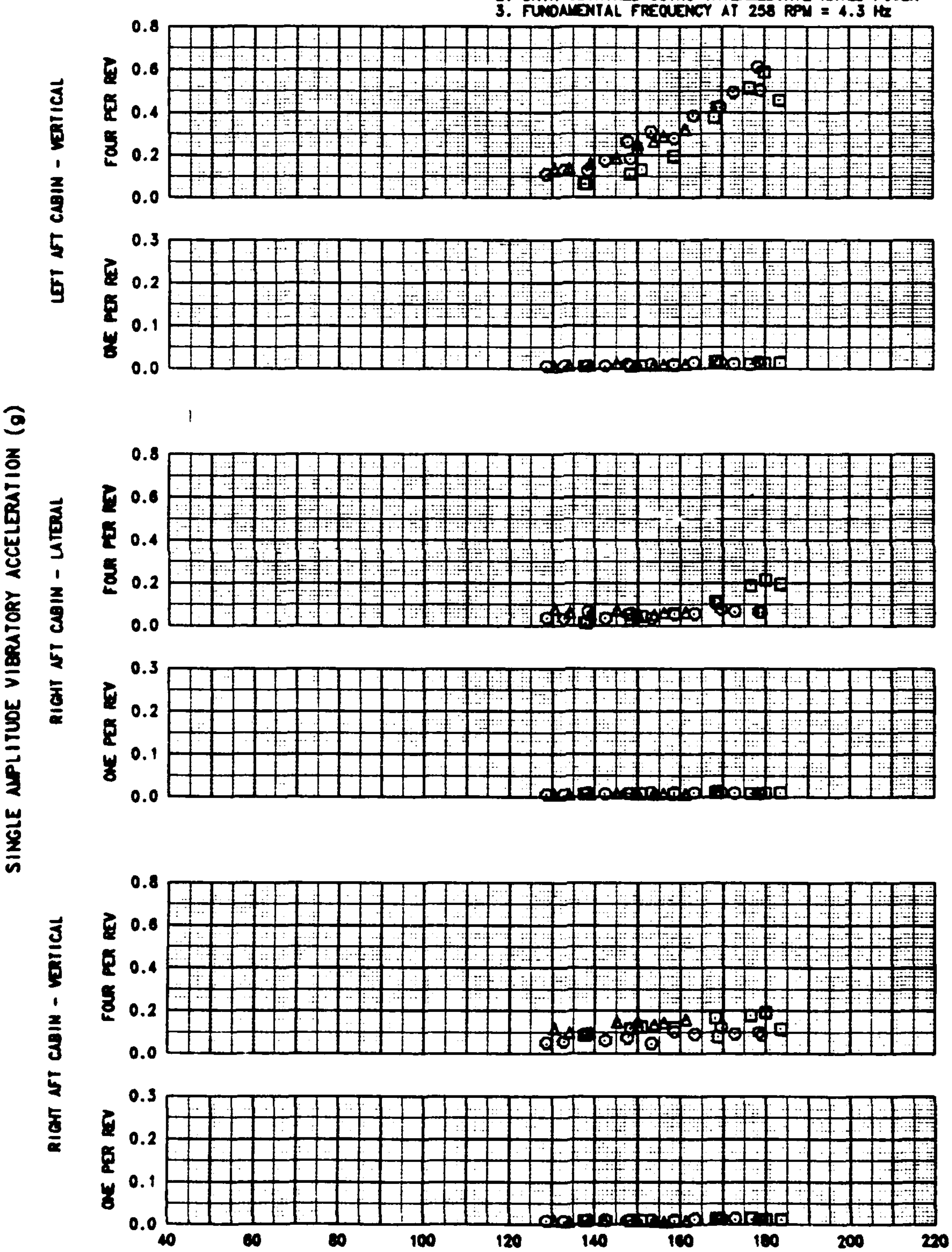


FIGURE E-69
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 122 KCAS
UH-60A USA S/N 82-23748

AFT CABIN FLOOR - STATION FS 398.0 BL 35.0 LT AND RT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15540	359.9 (AFT)	6160	14.0	258.2	0.006600
⊙	16140	360.7 (AFT)	8130	8.0	254.7	0.007486
△	17790	360.6 (AFT)	7870	8.5	255.1	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

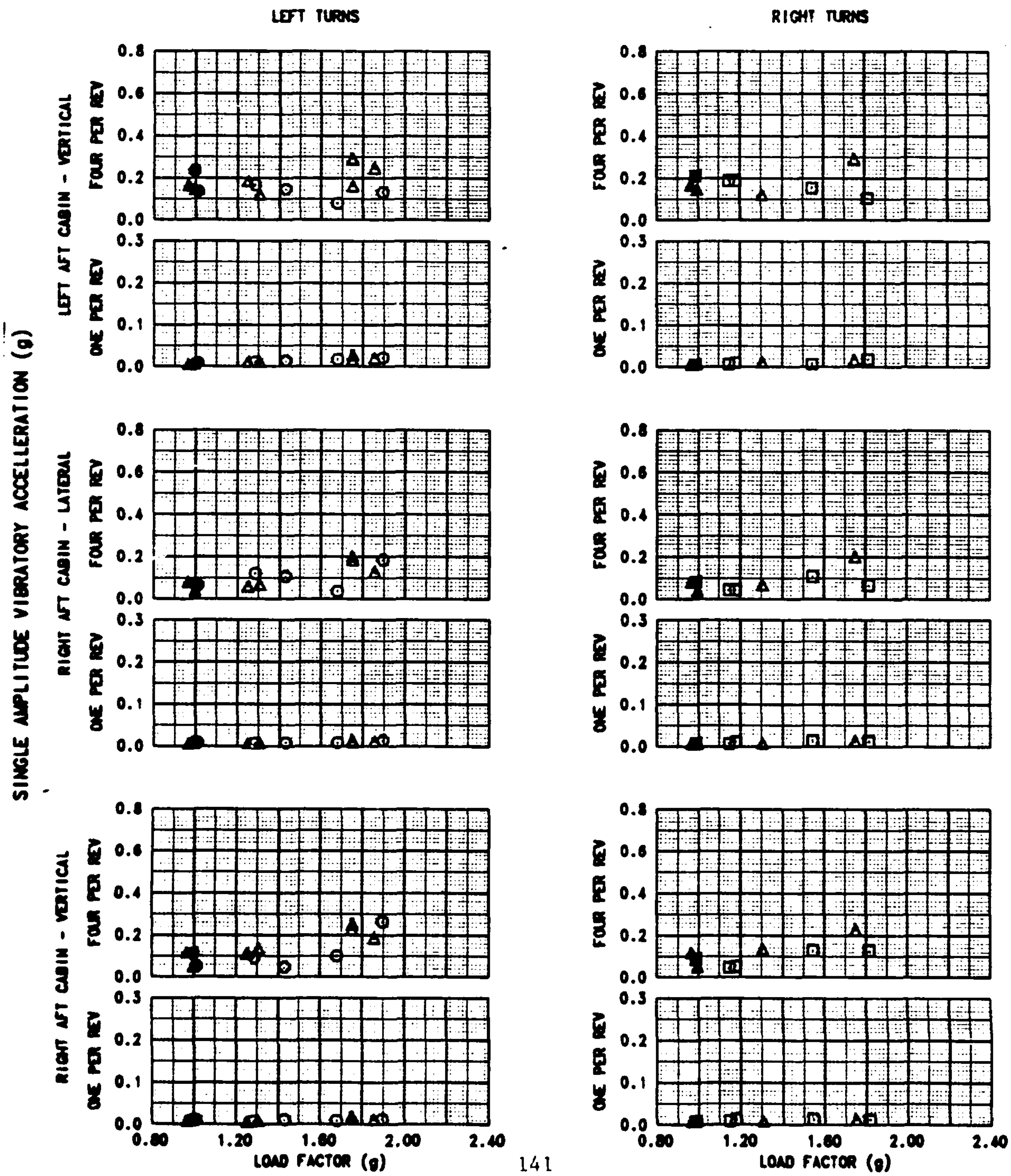


FIGURE E-70
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 140 KCAS
UH-60A USA S/N 82-23748

AFT CABIN FLOOR - STATION FS 398.0 BL 35.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15700	361.1 (AFT)	8850	6.0	254.5	0.007458
Δ	17570	360.7 (AFT)	8000	3.0	252.6	0.008251

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

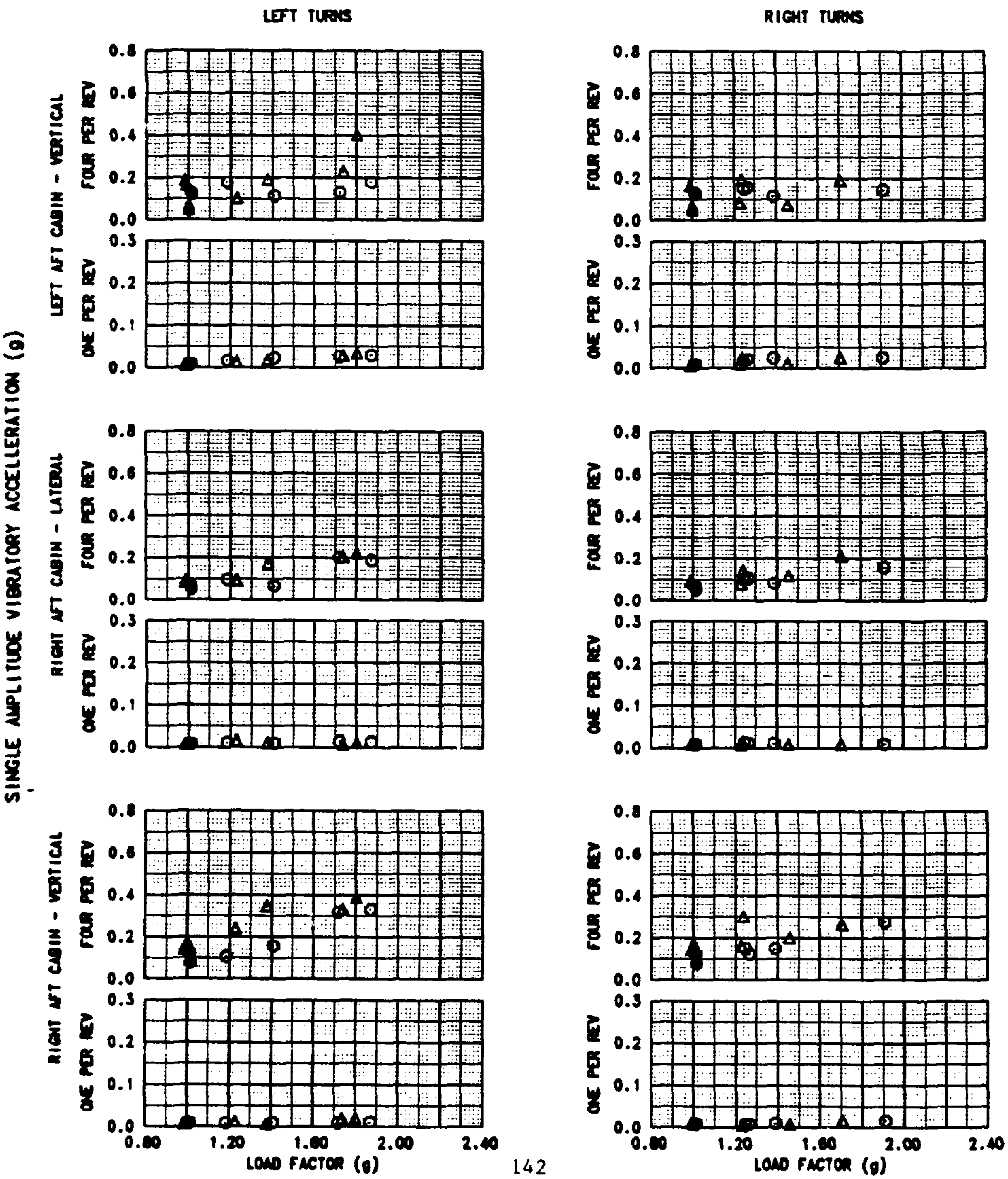


FIGURE E-71
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 150 KCAS
UH-60A USA S/N 82-23748

AFT CABIN FLOOR - STATION FS 398.0 BL 35.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15610	361.2 (AFT)	8820	6.5	254.2	0.007426
Δ	17200	360.7 (AFT)	8380	1.0	251.1	0.008271

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

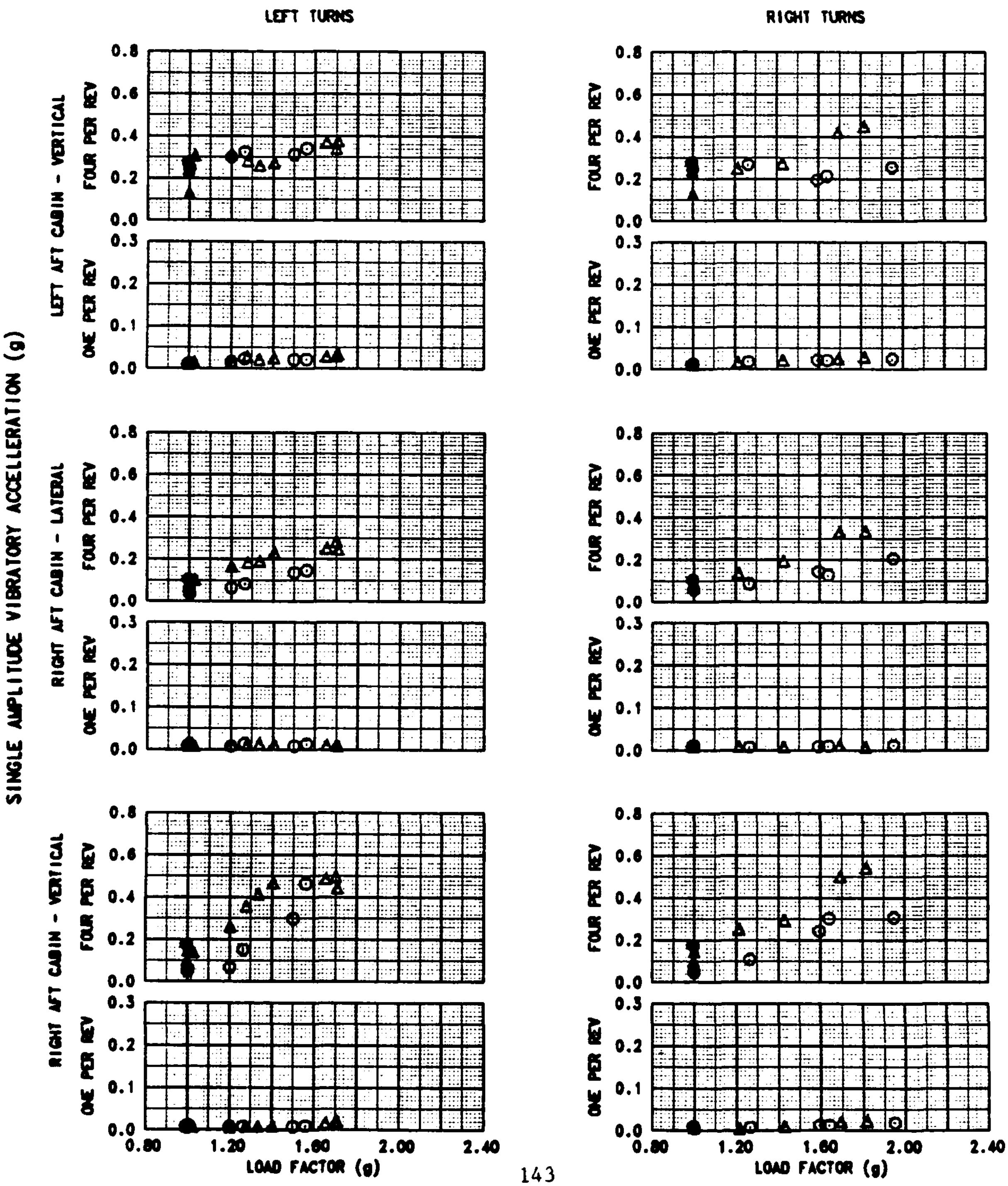


FIGURE E-72
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 160 KCAS
UH-60A USA S/N 82-23748

AFT CABIN FLOOR - STATION FS 398.0 BL 35.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15920	360.7 (AFT)	8600	8.0	255.5	0.007451
△	17100	360.8 (AFT)	9080	4.5	253.0	0.008279

NOTES:
1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

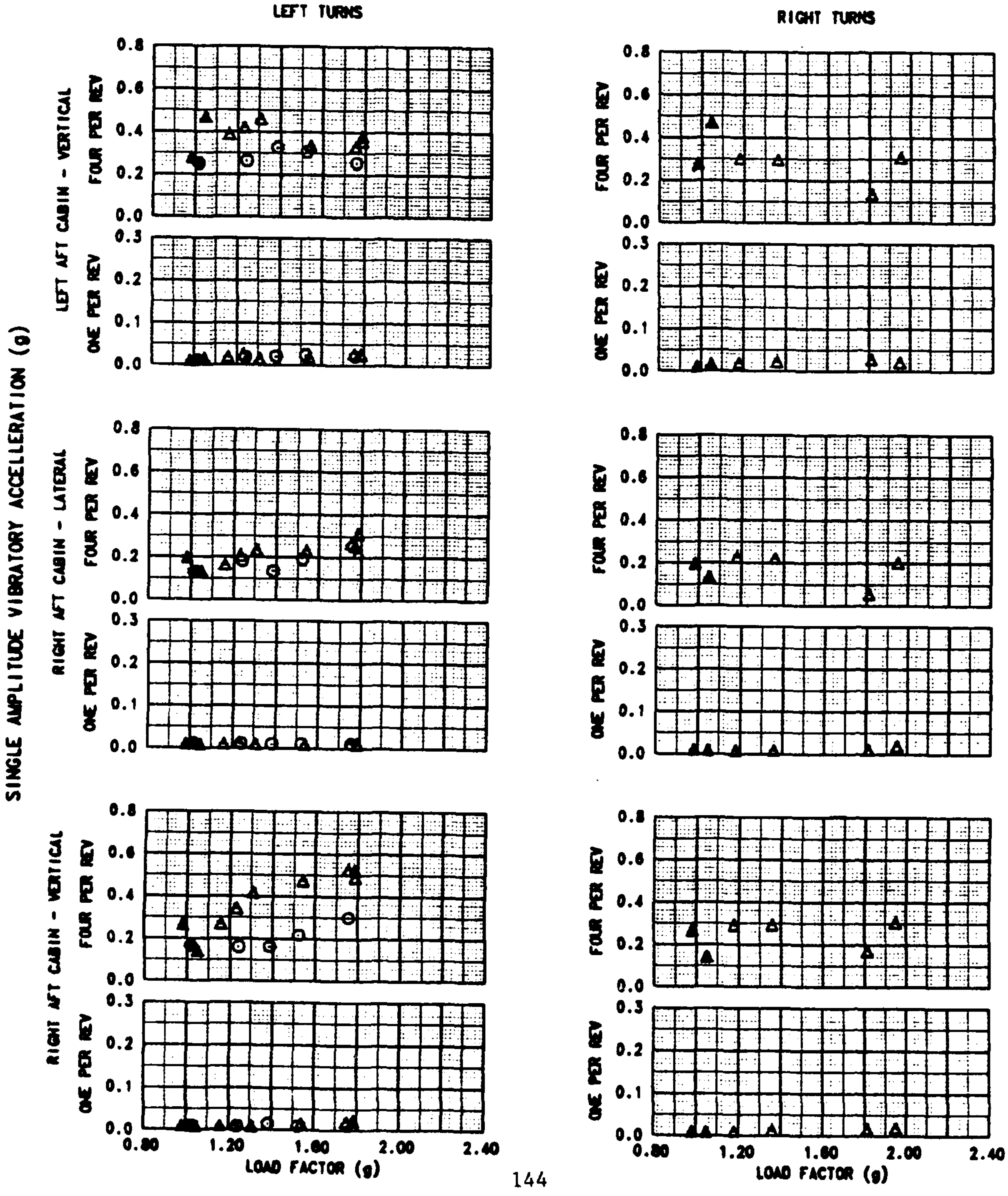


FIGURE E-73
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

AFT CABIN FLOOR - STATION FS 398.0 BL 35.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15400	361.5 (AFT)	9040	6.6	253.6	0.007388
△	17280	361.6 (AFT)	9130	9.0	254.8	0.008260

NOTES:
1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

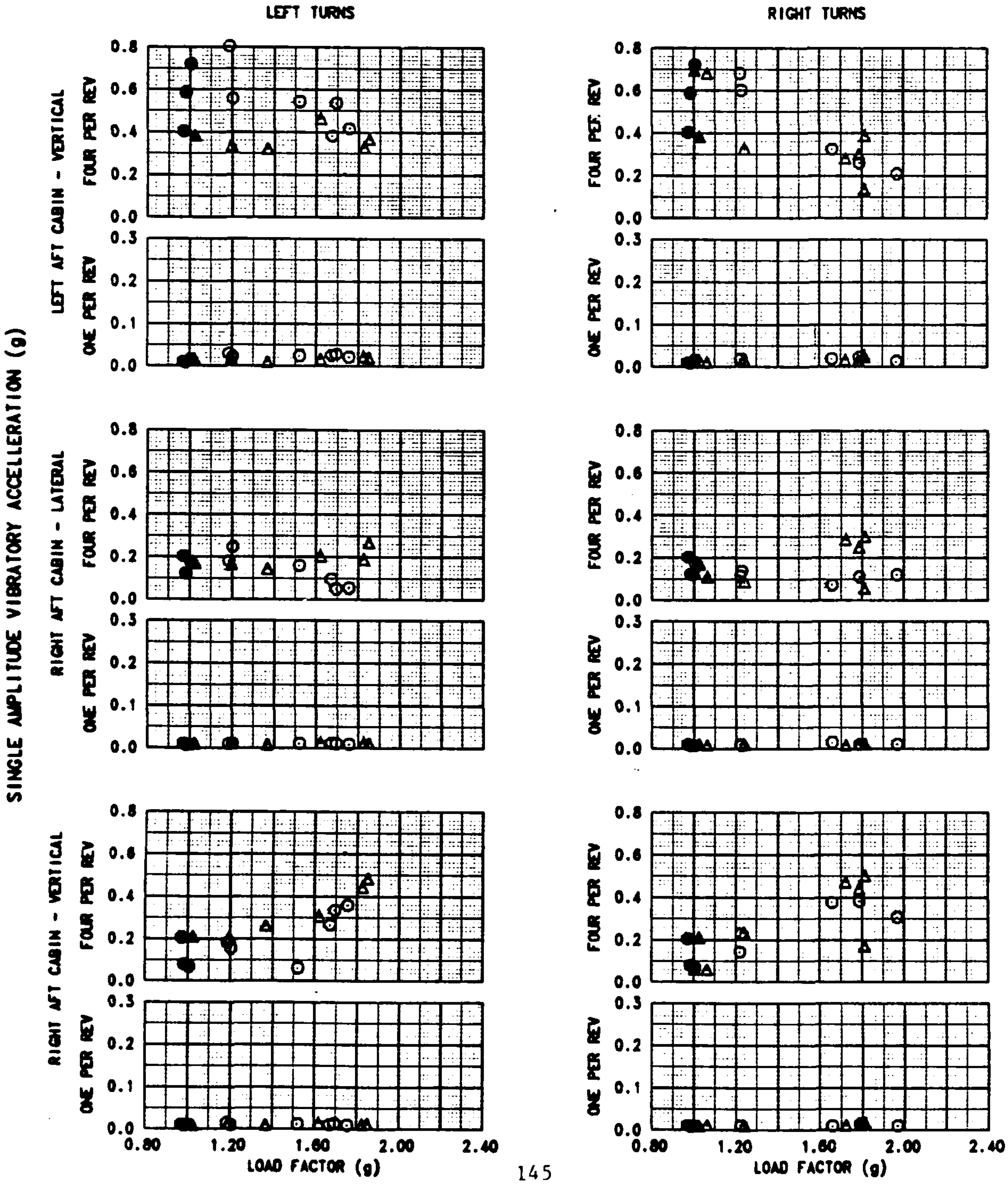


FIGURE E-74
VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

STABILATOR TIP - STATION FS 702.0 BL 83.5 LT AND RT WL 247.0

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15560	361.0(AFT)	5750	12.5	258.5	0.006595
○	17080	360.8(AFT)	6930	14.0	258.2	0.007485
△	19040	360.5(AFT)	6900	15.5	258.5	0.008252

NOTE: FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

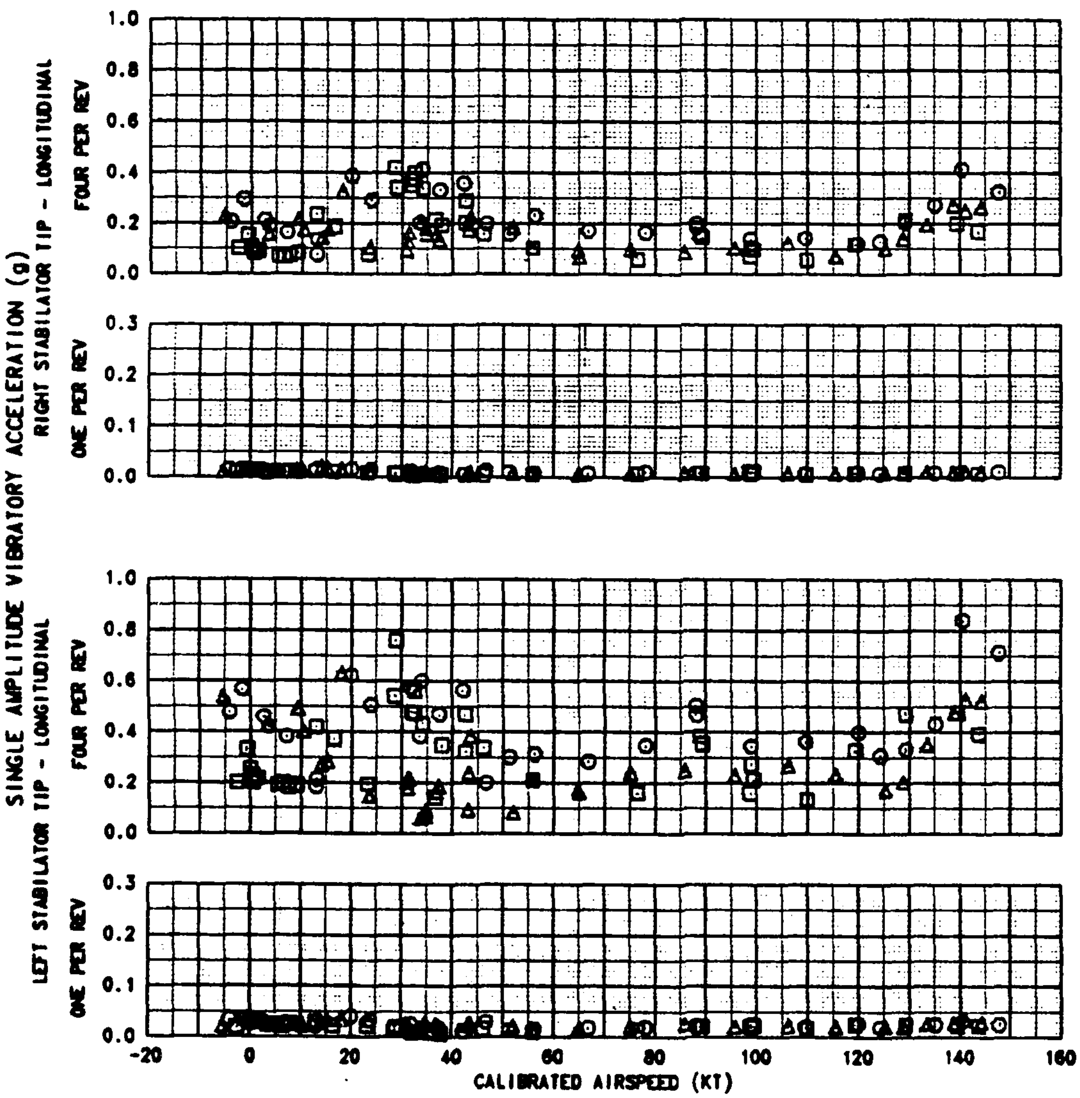


FIGURE E-75
VIBRATION CHARACTERISTICS IN CLIMBS AND POWERED DESCENTS
UH-60A USA S/N 82-23748

STABILATOR TIP - STATION FS 702.0 BL 83.5 LT AND RT WL 247.0

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	257.3	0.006819
⊙	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5160	7.0	254.8	0.008252

NOTES: 1. SHADED SYMBOL DENOTES LEVEL FLIGHT
2. DATA OBTAINED USING INTERMEDIATE RATED POWER
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

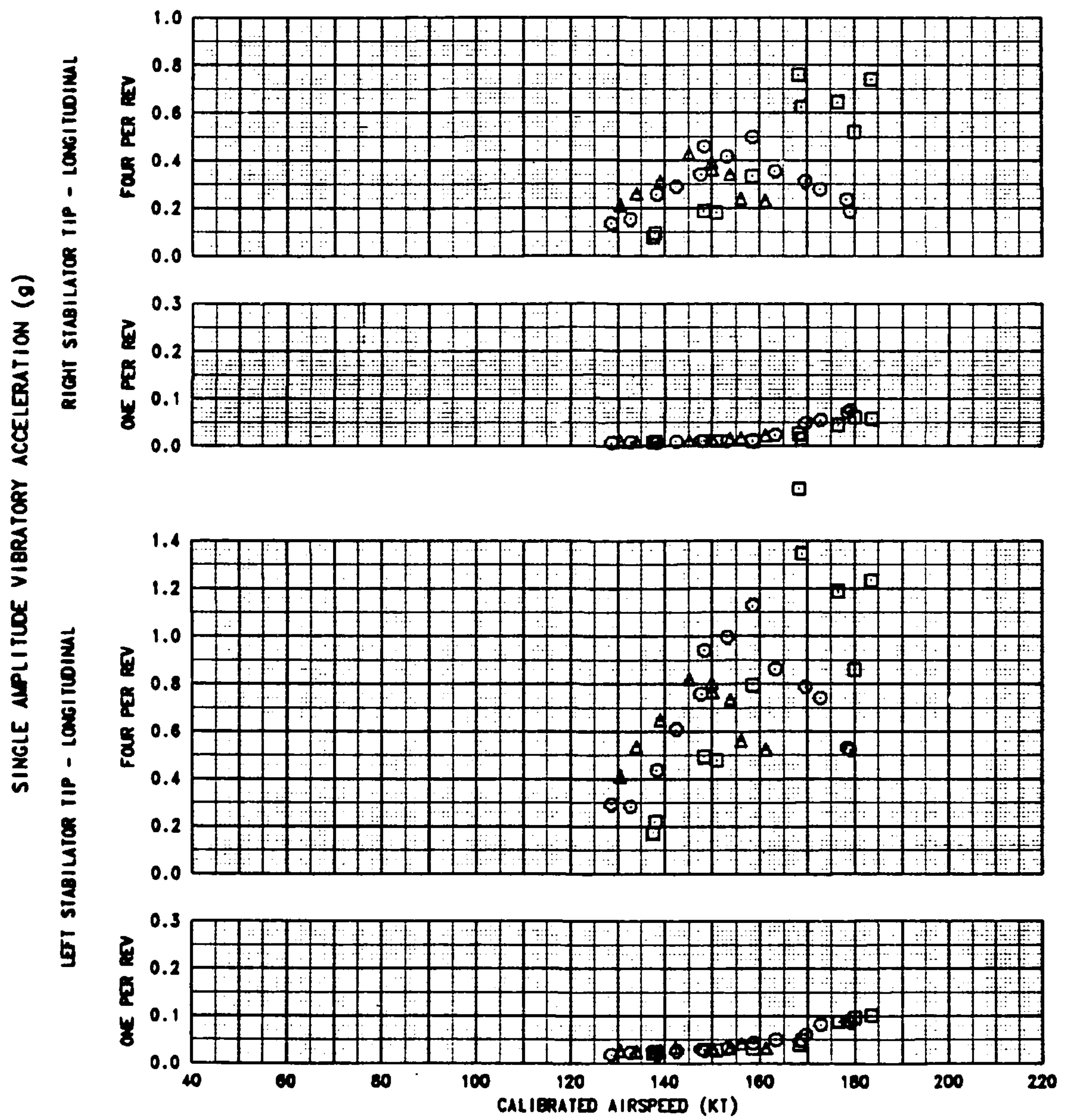


FIGURE E-76
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 122 KCAS
UH-60A USA S/N 82-23748

STABILATOR TIP - STATION FS 702.0 BL 83.5 LT ANT RT WL 247.0

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15540	359.9 (AFT)	6160	14.0	258.2	0.006600
⊙	16140	360.7 (AFT)	8130	8.0	254.7	0.007486
△	17790	360.8 (AFT)	7870	8.5	255.1	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

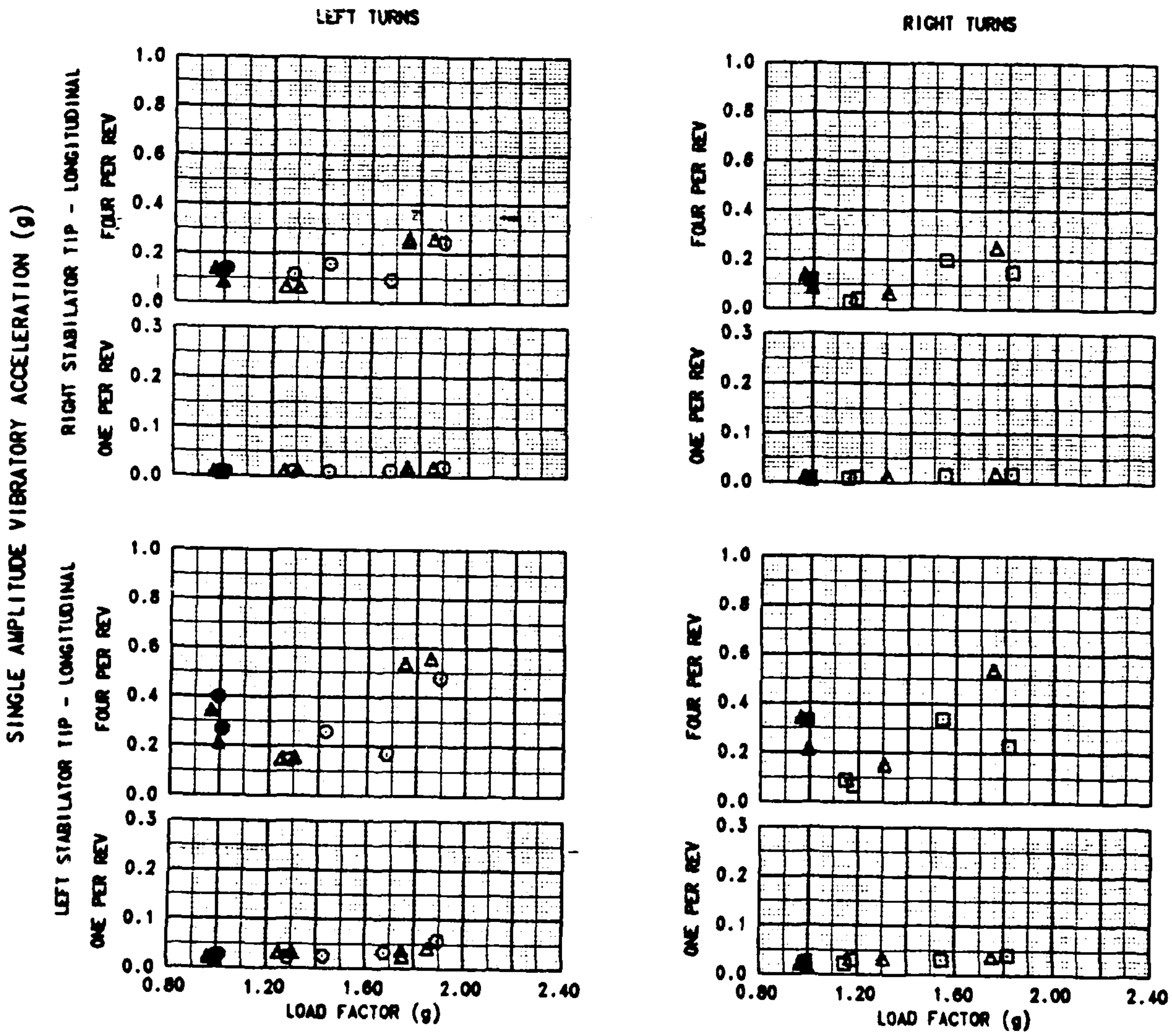


FIGURE E-77
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 140 KCAS
UH-60A USA S/N 82-23748

STABILATOR TIP - STATION FS 702.0 BL 83.5 LT AND RT WL 247.0

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15700	361.1 (AFT)	8850	6.0	254.5	0.007458
Δ	17570	360.7 (AFT)	8000	3.0	252.6	0.008251

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

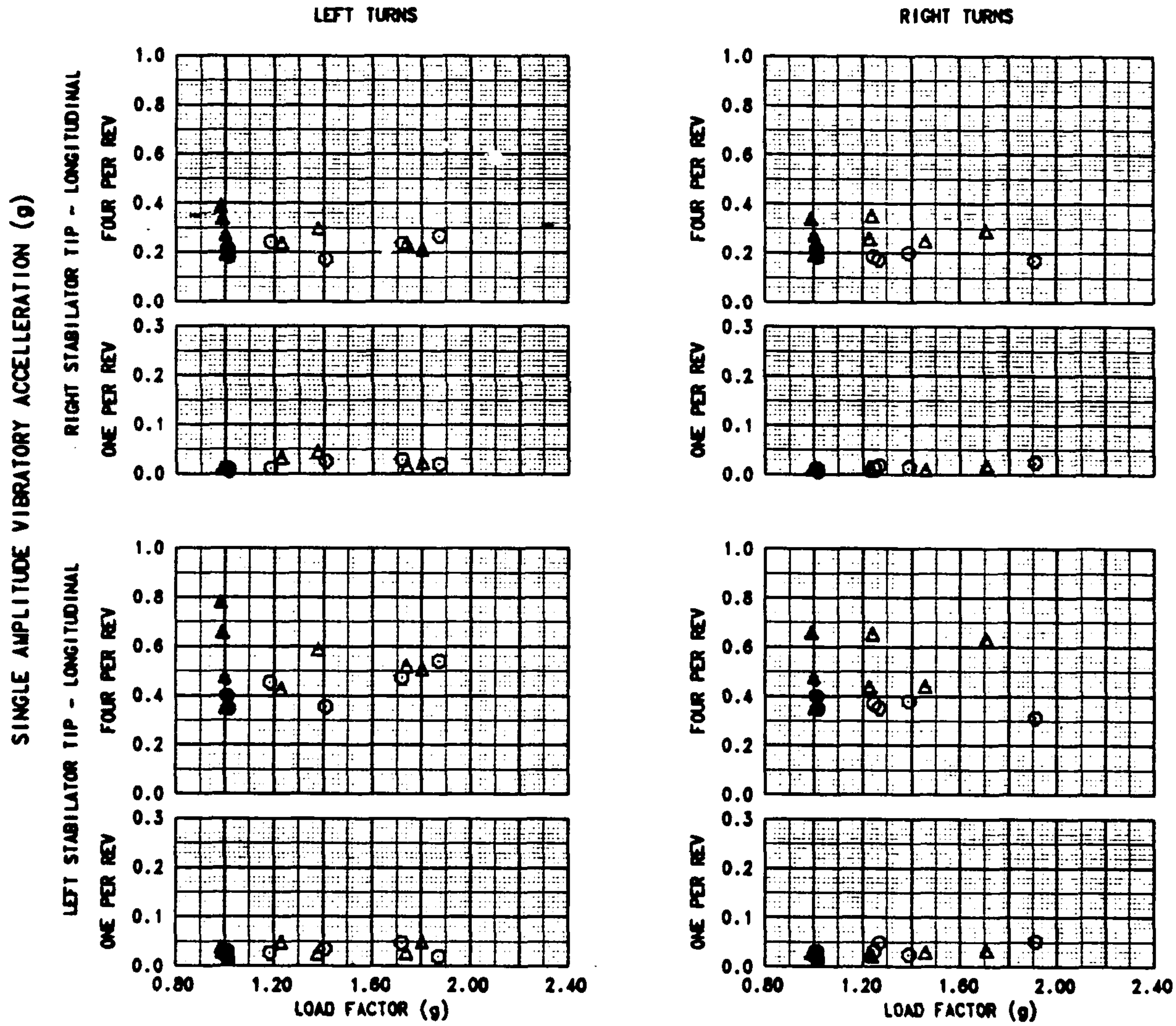


FIGURE E-78
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 150 KCAS
UH-60A USA S/N 82-23748

STABILATOR TIP - STATION FS 702.0 BL 83.5 LT AND RT WL 247.0

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15610	361.2 (AFT)	8820	6.5	254.2	0.007426
△	17200	360.7 (AFT)	8380	1.0	251.1	0.008271

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

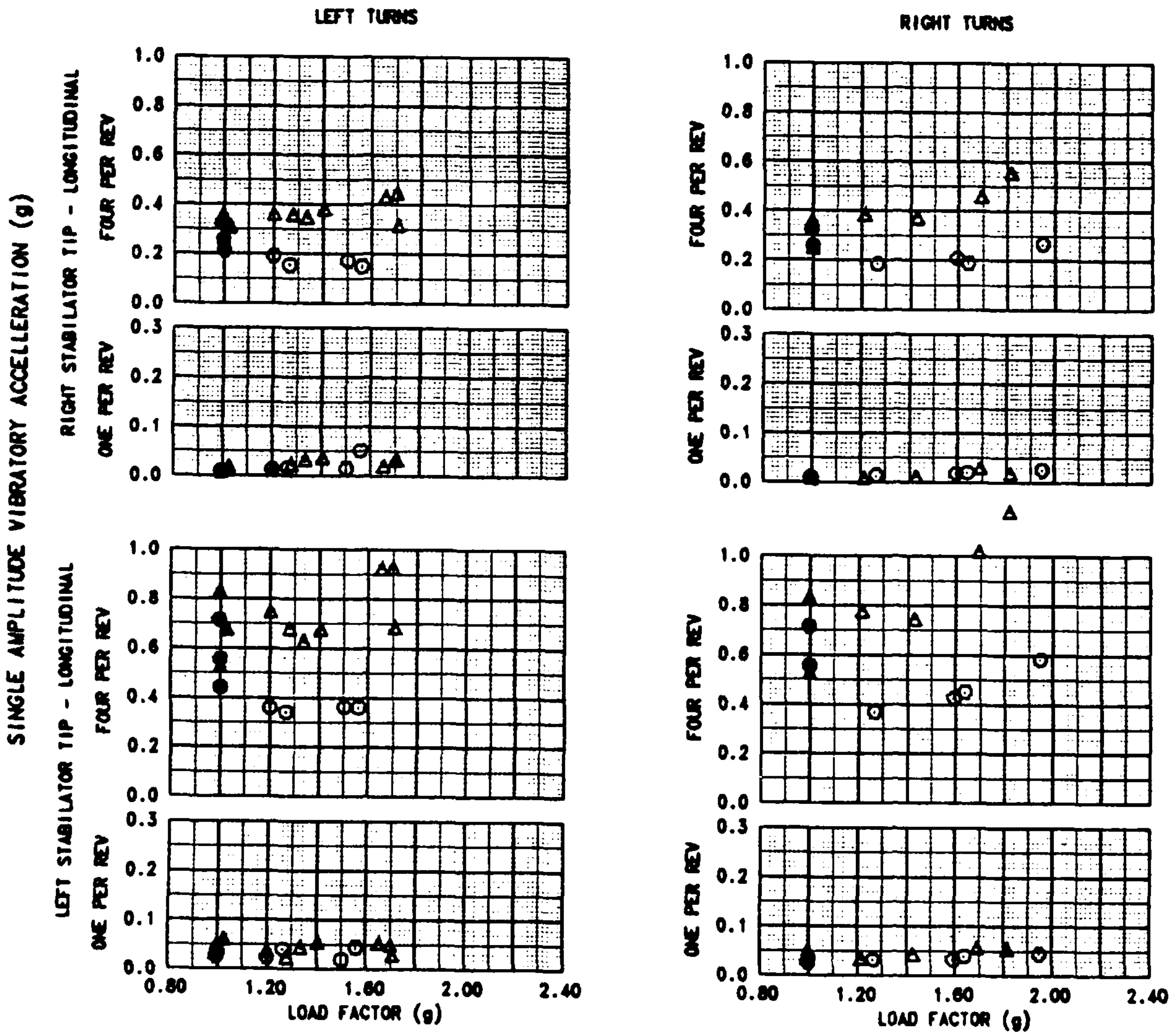


FIGURE E-79
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 160 KCAS
UH-60A USA S/N 82-23748

STABILATOR TIP - STATION FS 702.0 BL 83.5 LT AND RT WL 247.0

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15920	360.7 (AFT)	8600	8.0	255.5	0.007451
△	17100	360.8 (AFT)	9080	4.5	253.0	0.008279

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

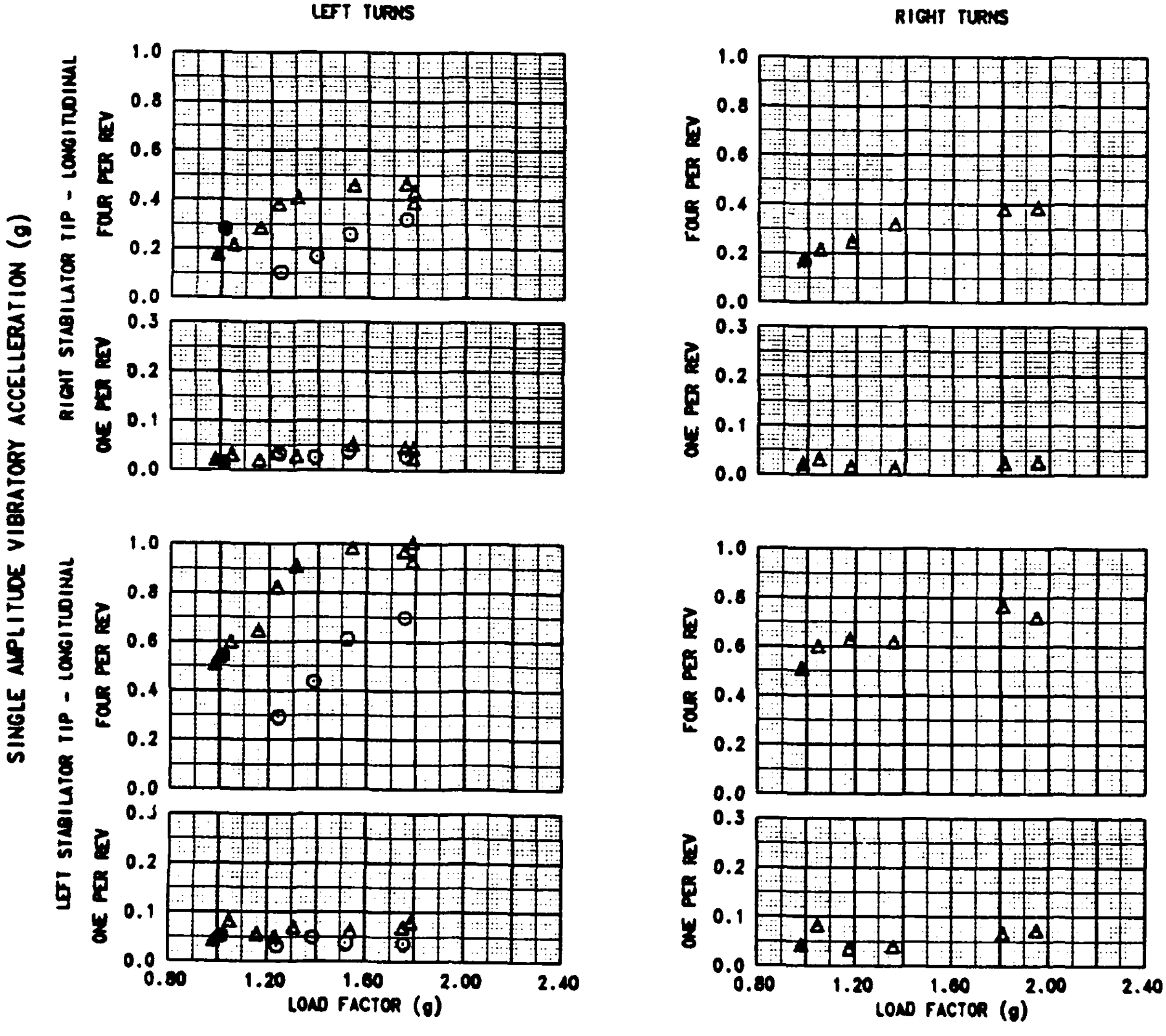


FIGURE E-80
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

STABILATOR TIP - STATION FS 702.0 BL 83.5 LT AND RT WL 247.0

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15400	361.5 (AFT)	9040	6.6	253.6	0.007388
Δ	17280	361.8 (AFT)	9130	9.0	254.8	0.008260

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

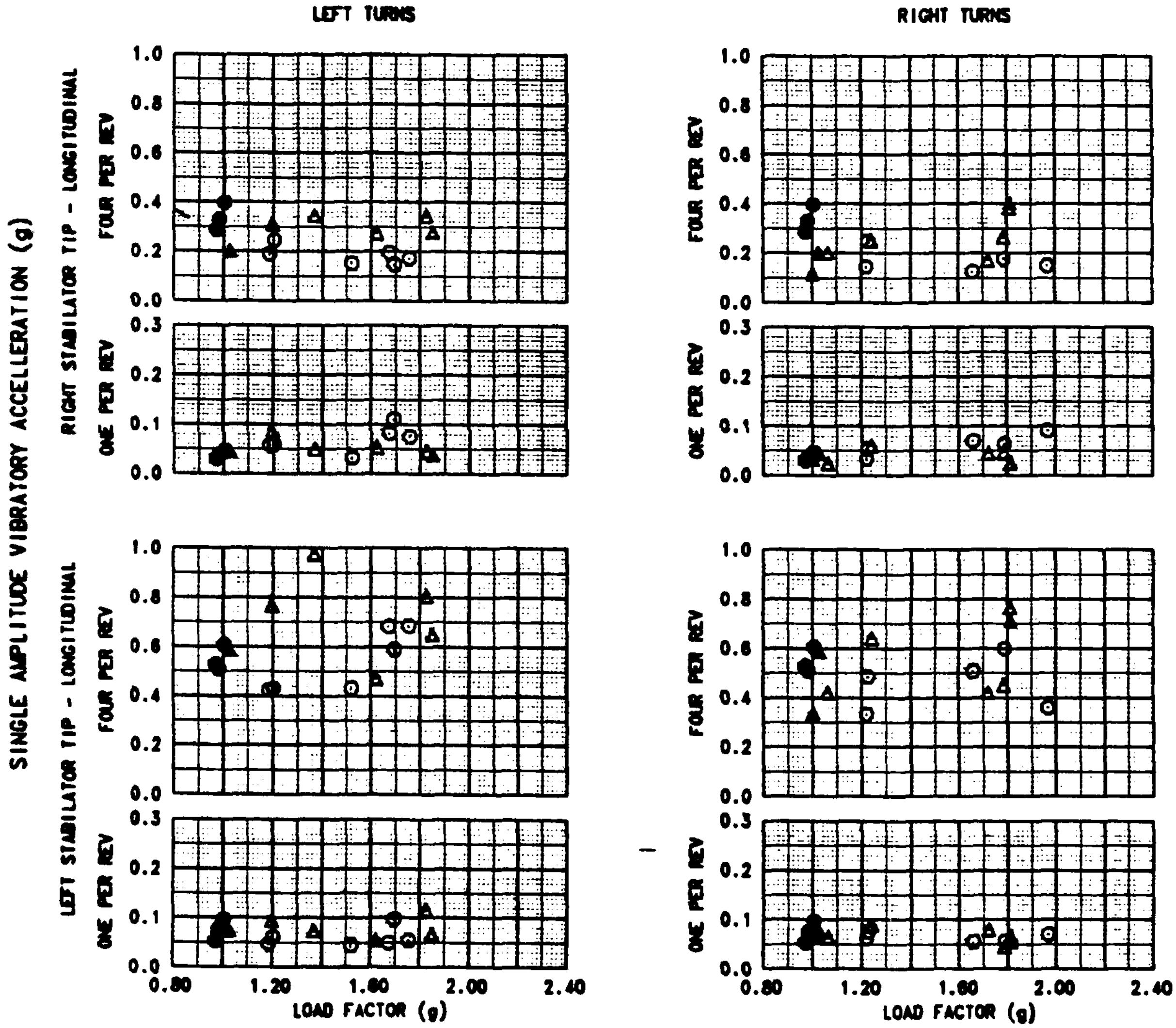


FIGURE E-81
VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

TAIL ROTOR GEARBOX - STATION FS 732.0 BL 0.0 WL 325.0

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15560	361.0(AFT)	5750	12.5	258.5	0.006595
○	17080	360.8(AFT)	6930	14.0	258.2	0.007465
△	19040	360.5(AFT)	6900	15.5	258.5	0.008252

NOTE: FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

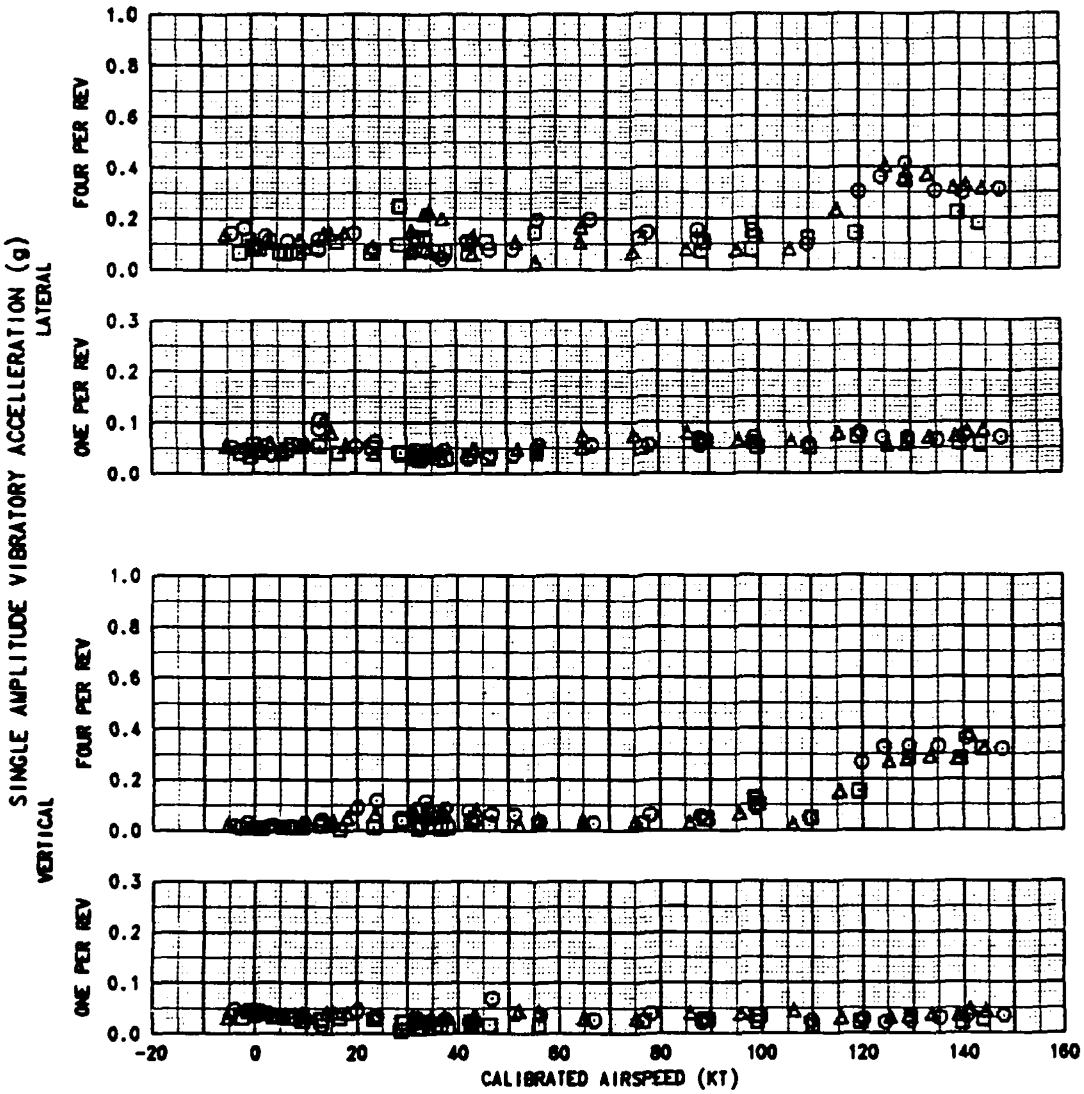


FIGURE E-82
VIBRATION CHARACTERISTICS IN CLIMBS AND POWERED DESCENTS
UH-60A USA S/N 82-23748

TAIL ROTOR GEARBOX - STATION FS 702.0 BL 83.5 LT AND RT WL 247.0

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	257.3	0.006619
○	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5180	7.0	254.8	0.008252

NOTES: 1. SHADED SYMBOL DENOTES LEVEL FLIGHT
2. DATA OBTAINED USING INTERMEDIATE RATED POWER
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

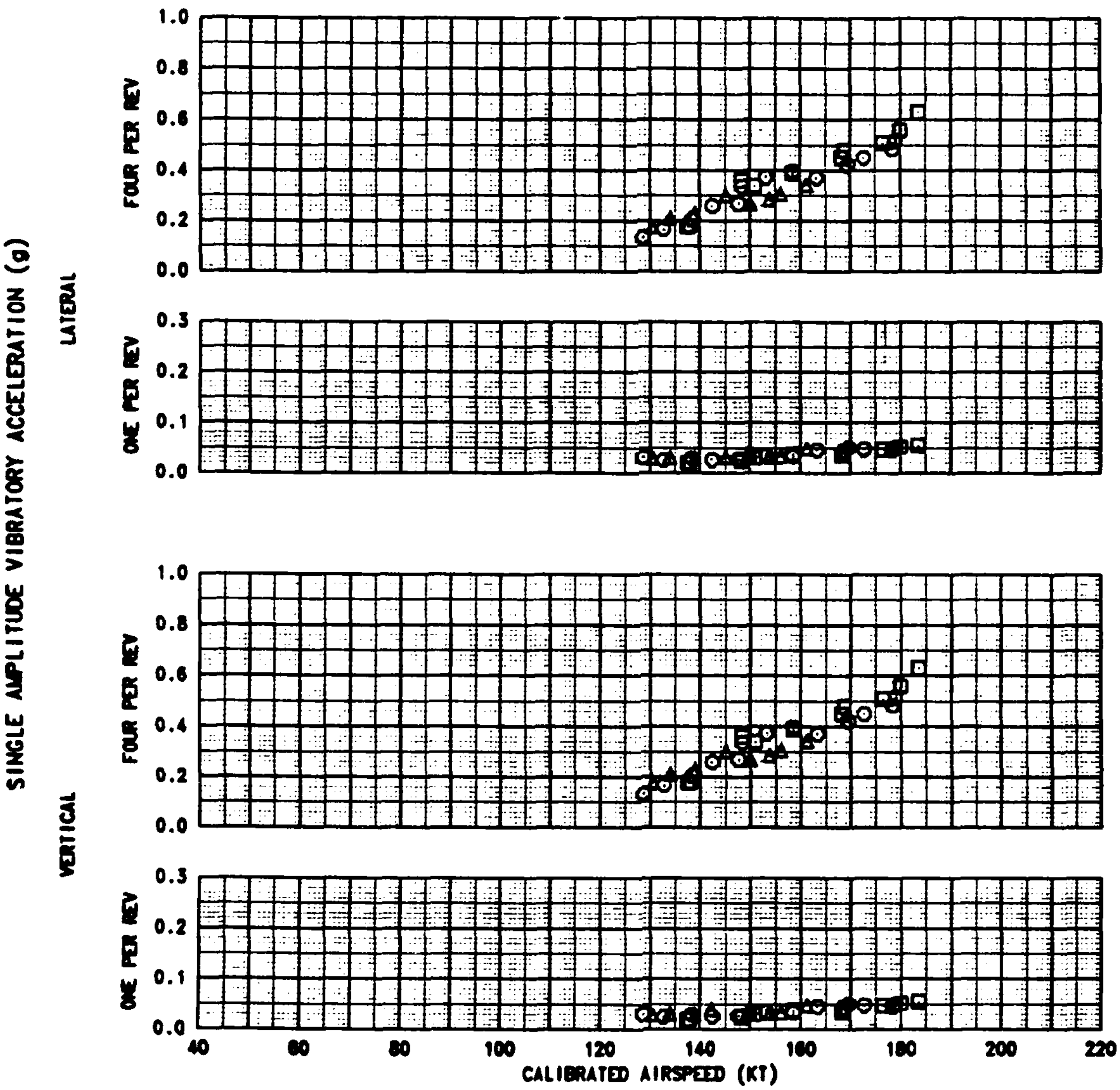


FIGURE E-83
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 122 KCAS
UH-60A USA S/N 82-23748

TAIL ROTOR GEARBOX - STATION FS 732.0 BL 0.0 WL 325.0

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15540	359.9 (AFT)	6160	14.0	258.2	0.006600
⊙	16140	360.7 (AFT)	8130	8.0	254.7	0.007486
△	17790	360.6 (AFT)	7870	8.5	255.1	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

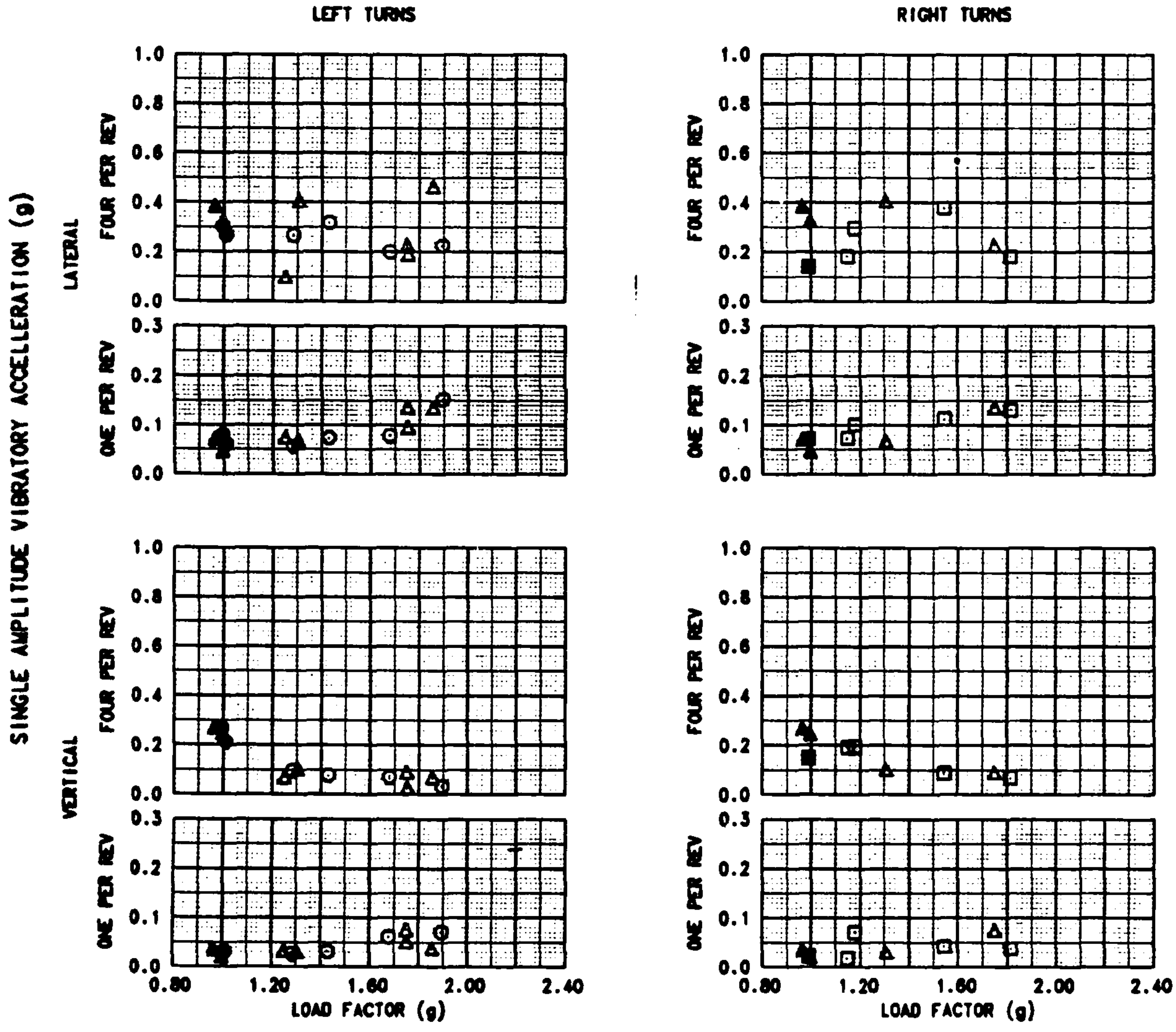


FIGURE E-84
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 140 KCAS
UH-60A USA S/N 82-23748

TAIL ROTOR GEARBOX - STATION FS 732.0 BL 0.0 WL 325.0

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15700	361.1 (AFT)	8850	6.0	254.5	0.007458
△	17570	360.7 (AFT)	8000	3.0	252.6	0.008251

NOTES:
1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

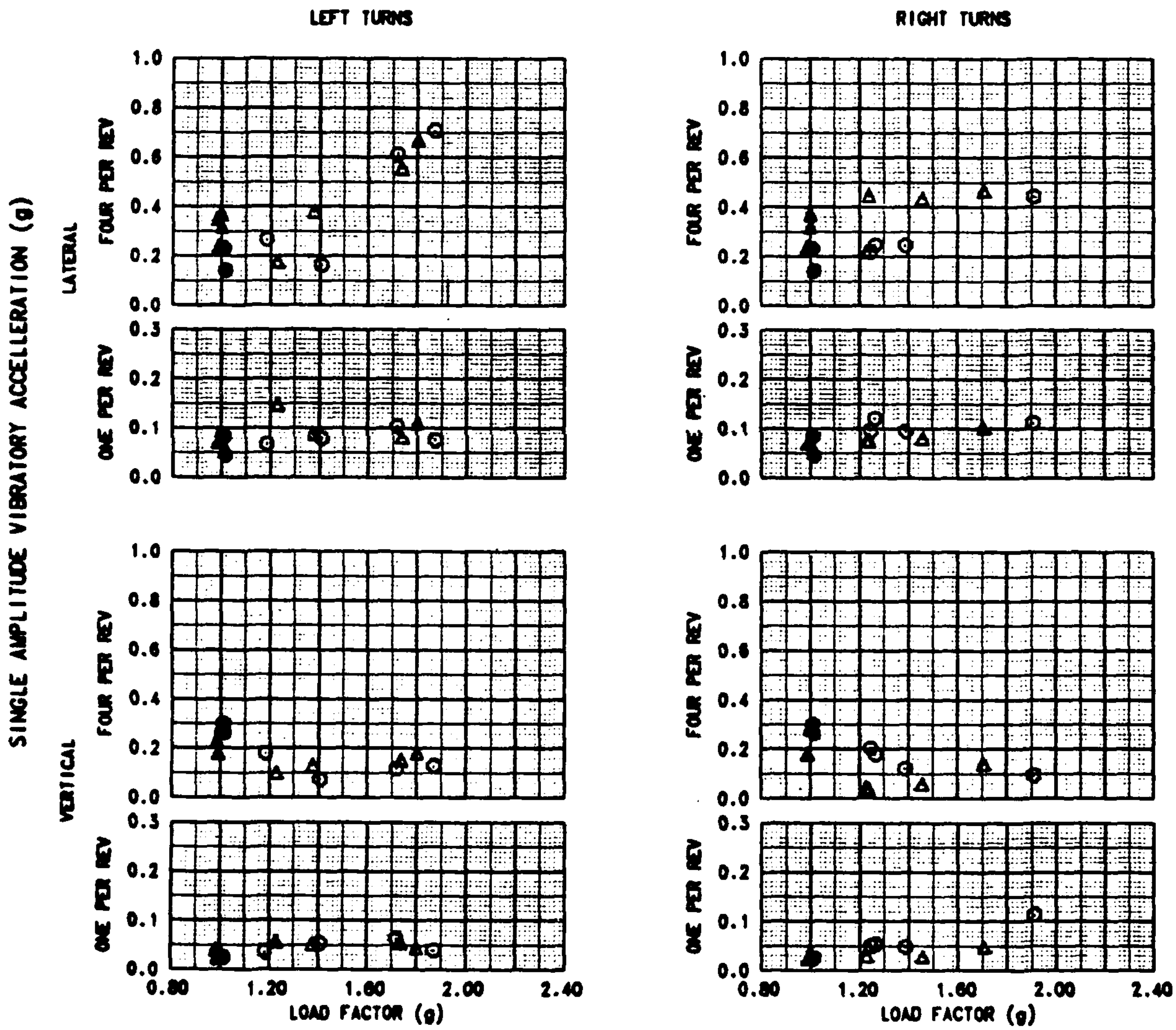


FIGURE E-85
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 150 KCAS
UH-60A USA S/N 82-23748

TAIL ROTOR GEARBOX - STATION FS 732.0 BL 0.0 WL 325.0

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15610	361.2 (AFT)	8820	6.5	254.2	0.007428
Δ	17200	360.7 (AFT)	8380	1.0	251.1	0.008271

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

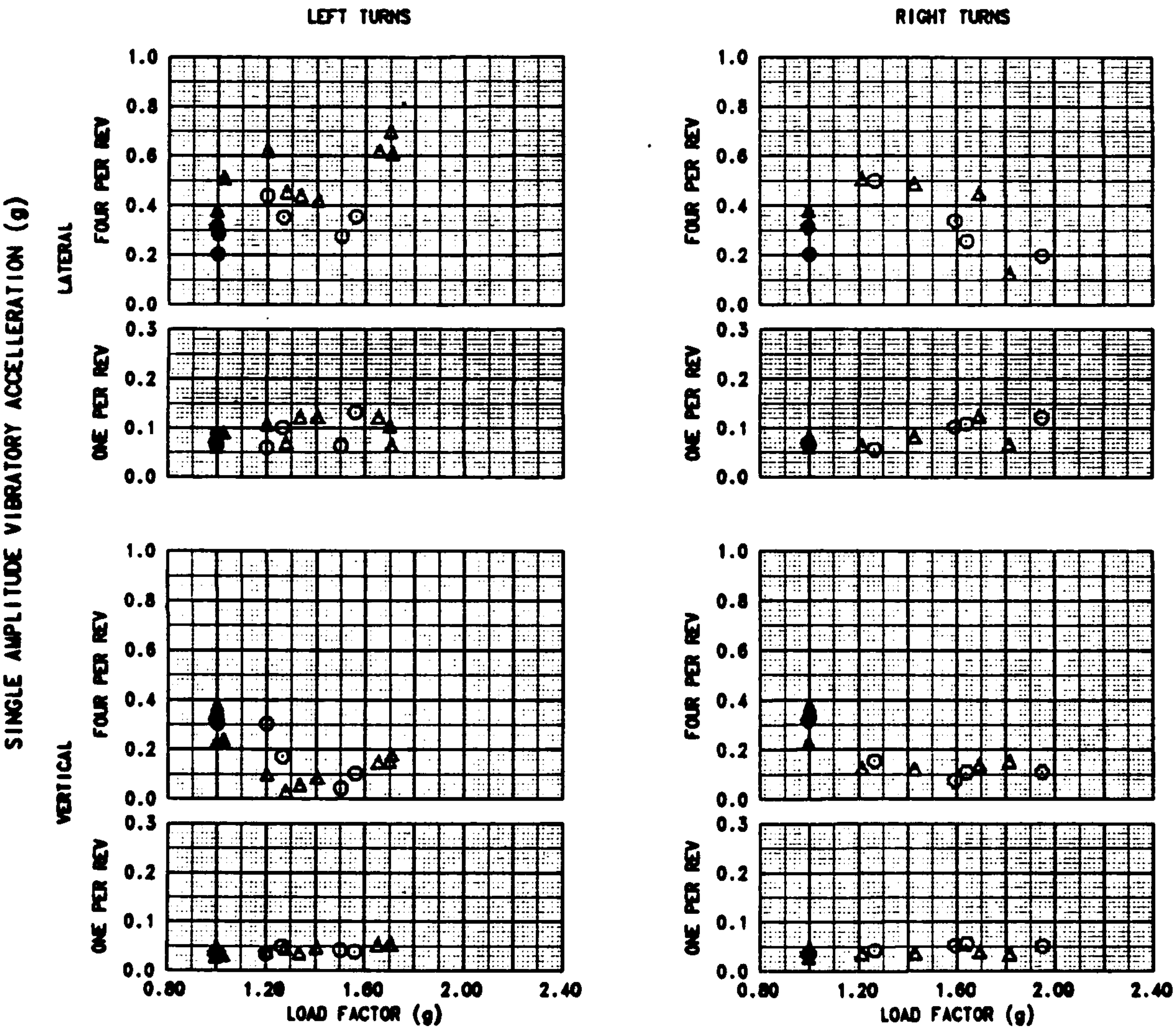


FIGURE E-86
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 160 KCAS
UH-60A USA S/N 82-23748

TAIL ROTOR GEARBOX - STATION FS 732.0 BL 0.0 WL 325.0

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15920	360.7 (AFT)	8600	8.0	255.5	0.007451
Δ	17100	360.8 (AFT)	9080	4.5	253.0	0.008279

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

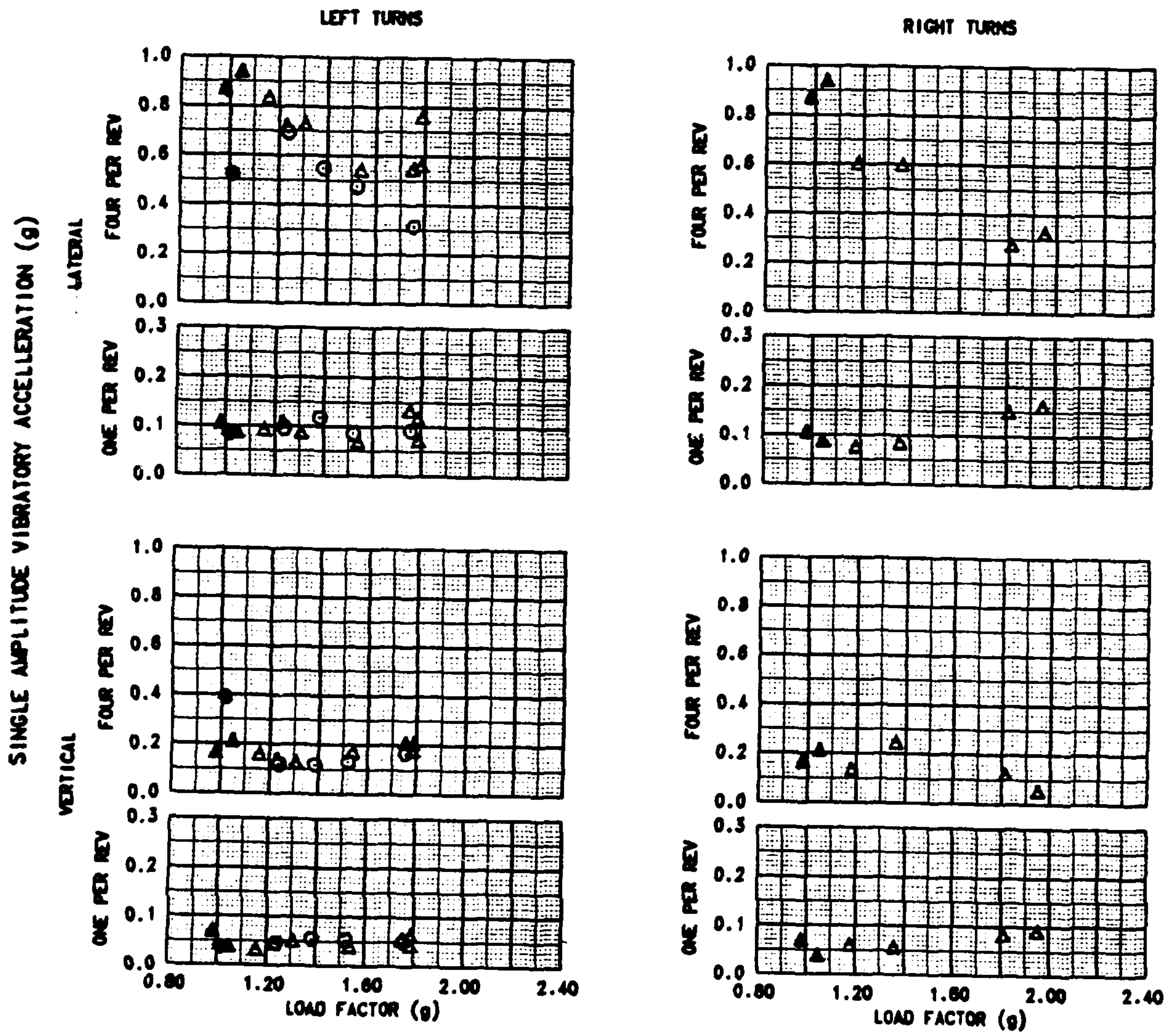


FIGURE E-87
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

TAIL ROTOR GEARBOX - STATION FS 732.0 BL 0.0 WL 325.0

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15400	361.5 (AFT)	9040	6.6	253.6	0.007388
△	17280	361.6 (AFT)	9130	9.0	254.8	0.008260

NOTES:
1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

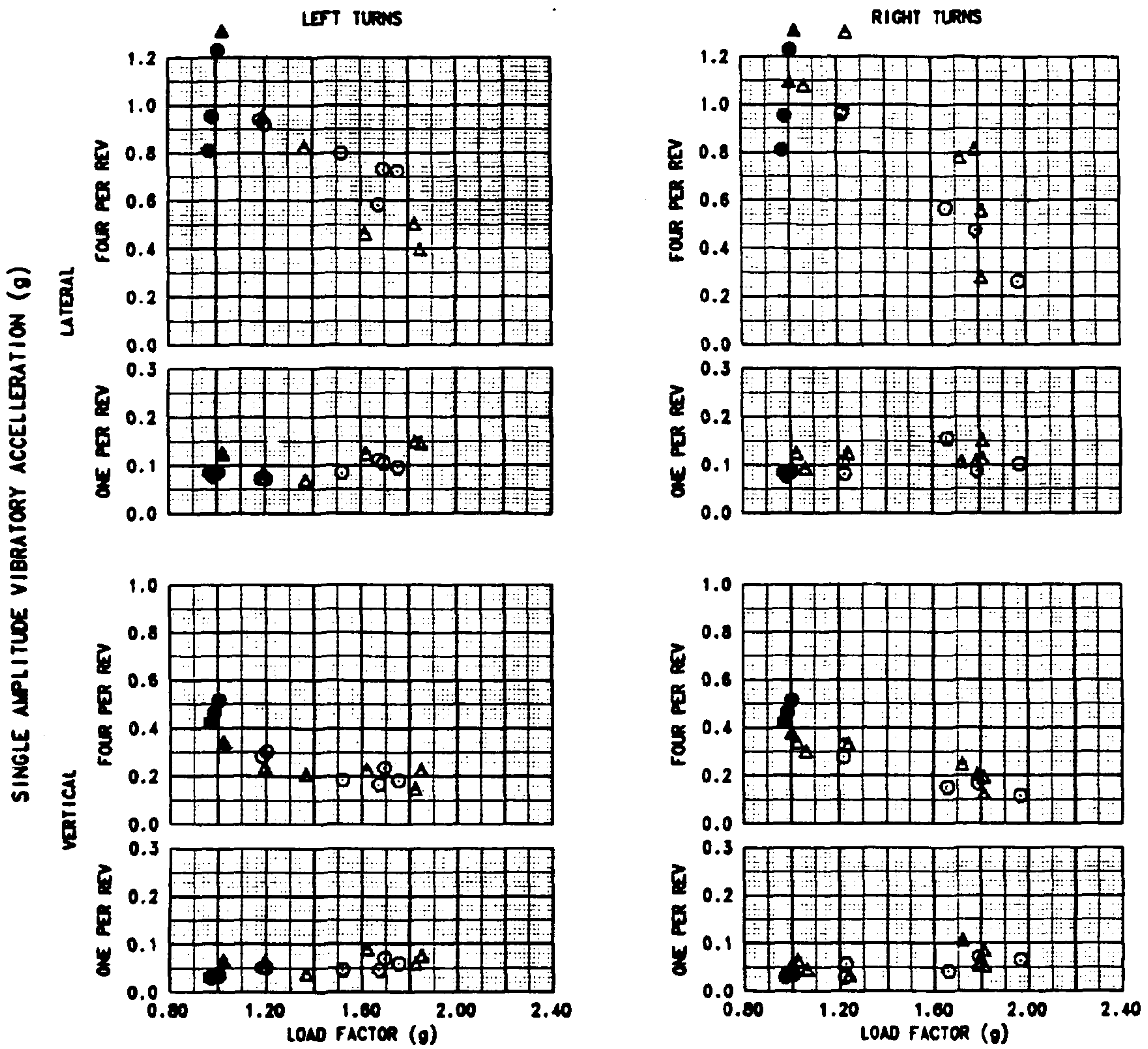


FIGURE E-88
VIBRATION CHARACTERISTICS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

MAIN ROTOR HUB - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15560	361.0(AFT)	5750	12.5	256.9	0.006595
⊙	17080	360.8(AFT)	6930	14.0	257.5	0.007465
Δ	19040	360.5(AFT)	6900	15.5	258.5	0.008252

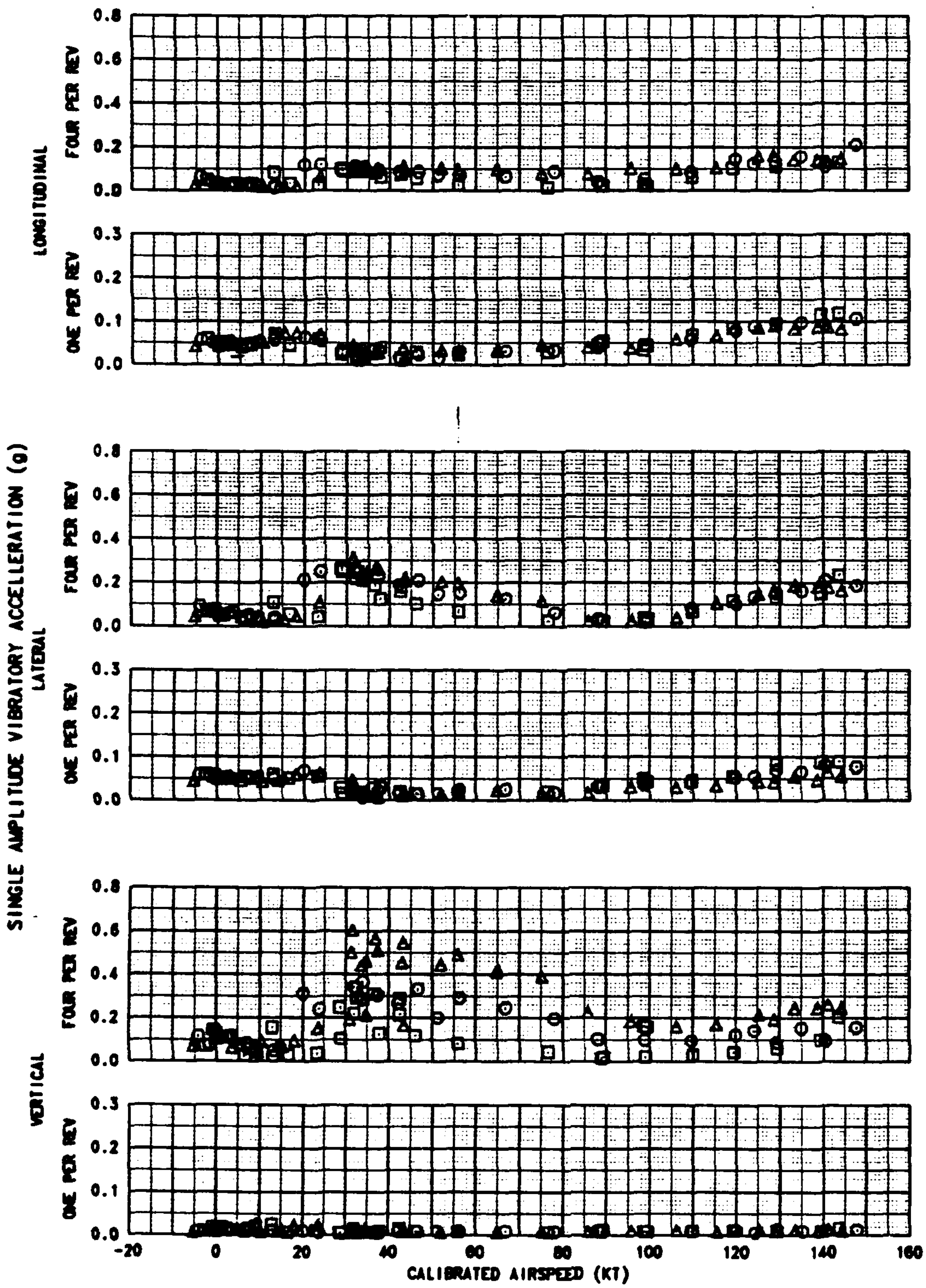


FIGURE E-89
VIBRATION CHARACTERISTICS IN CLIMBS AND POWERED DESCENTS
UH-60A USA S/N 82-23748

MAIN ROTOR HUB - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	257.3	0.006619
⊙	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5160	7.0	254.8	0.008252

NOTES: 1. SHADED SYMBOL DENOTES LEVEL FLIGHT
2. DATA OBTAINED USING INTERMEDIATE RATED POWER
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

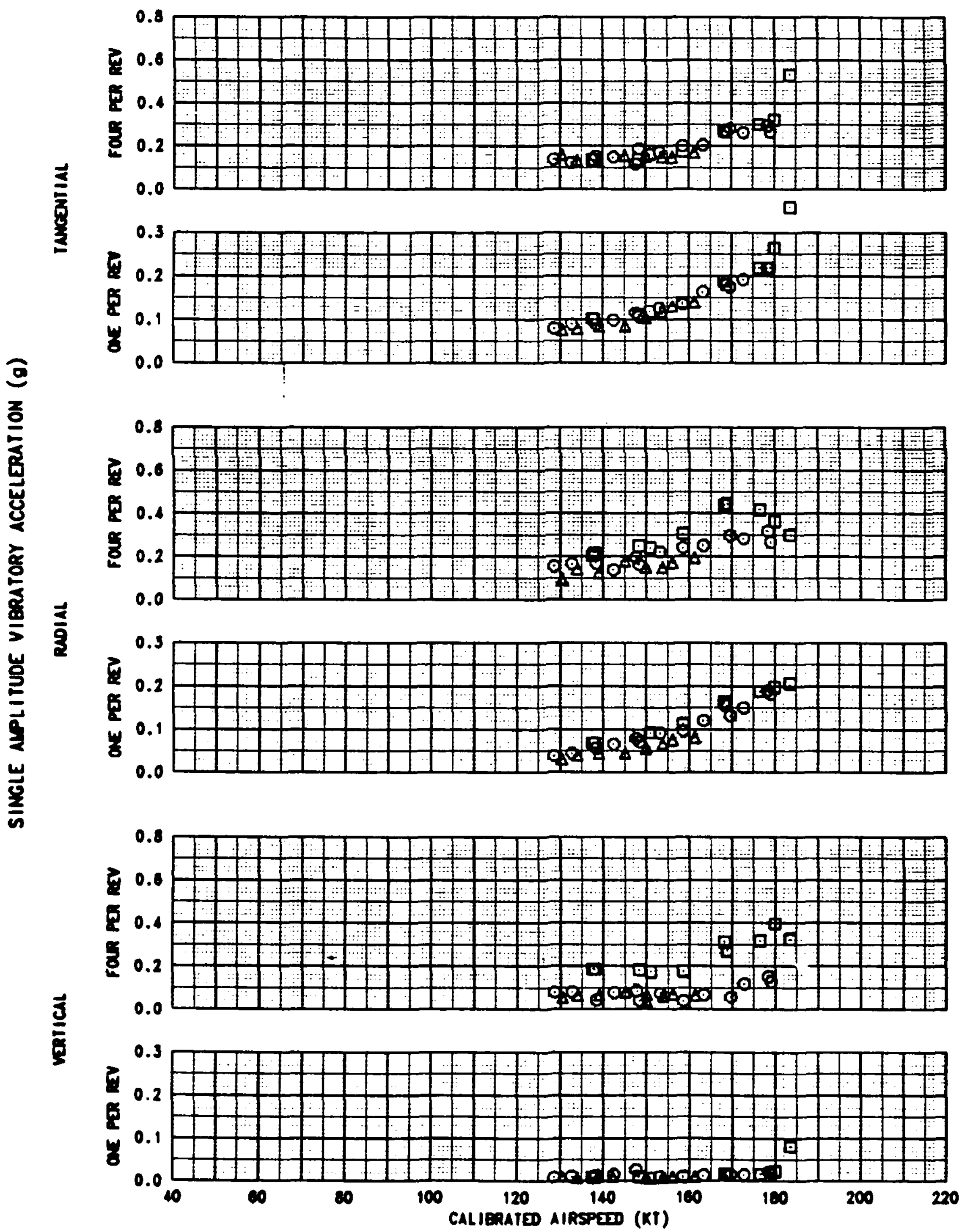


FIGURE E-90

VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 122 KCAS

UH-60A USA S/N 82-23748

MAIN ROTOR HUB - STATION FS 253.0 BL 31.0 RT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15540	359.9 (AFT)	8160	14.0	258.2	0.006600
○	16140	360.7 (AFT)	8130	8.0	254.7	0.007486
△	17790	360.6 (AFT)	7870	8.5	255.4	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

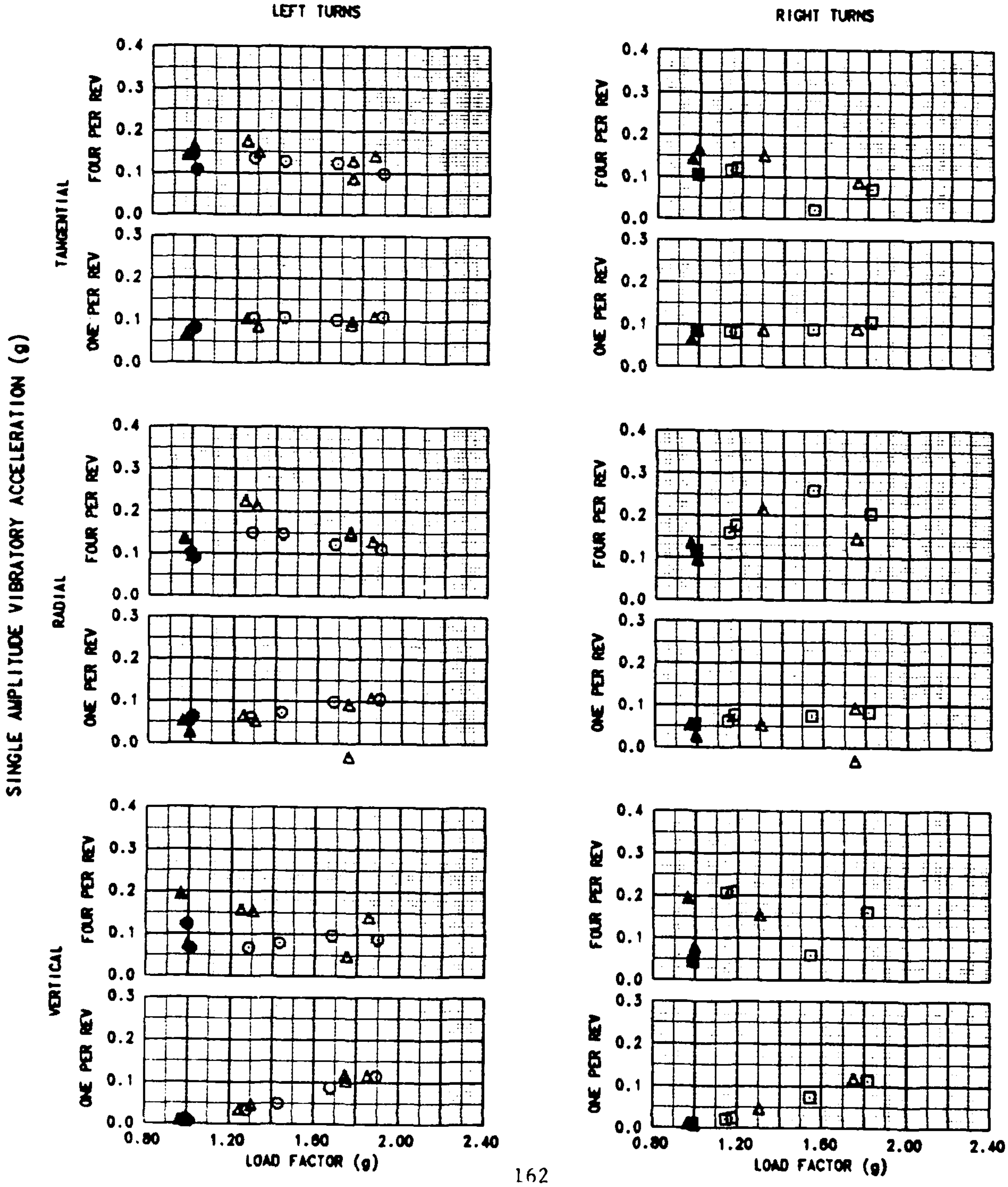


FIGURE E-91
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 140 KCAS
UH-60A USA S/N 82-23748

MAIN ROTOR HUB - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15700	361.1 (AFT)	8850	6.0	254.5	0.007458
Δ	17570	360.7 (AFT)	8000	3.0	252.8	0.008251

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

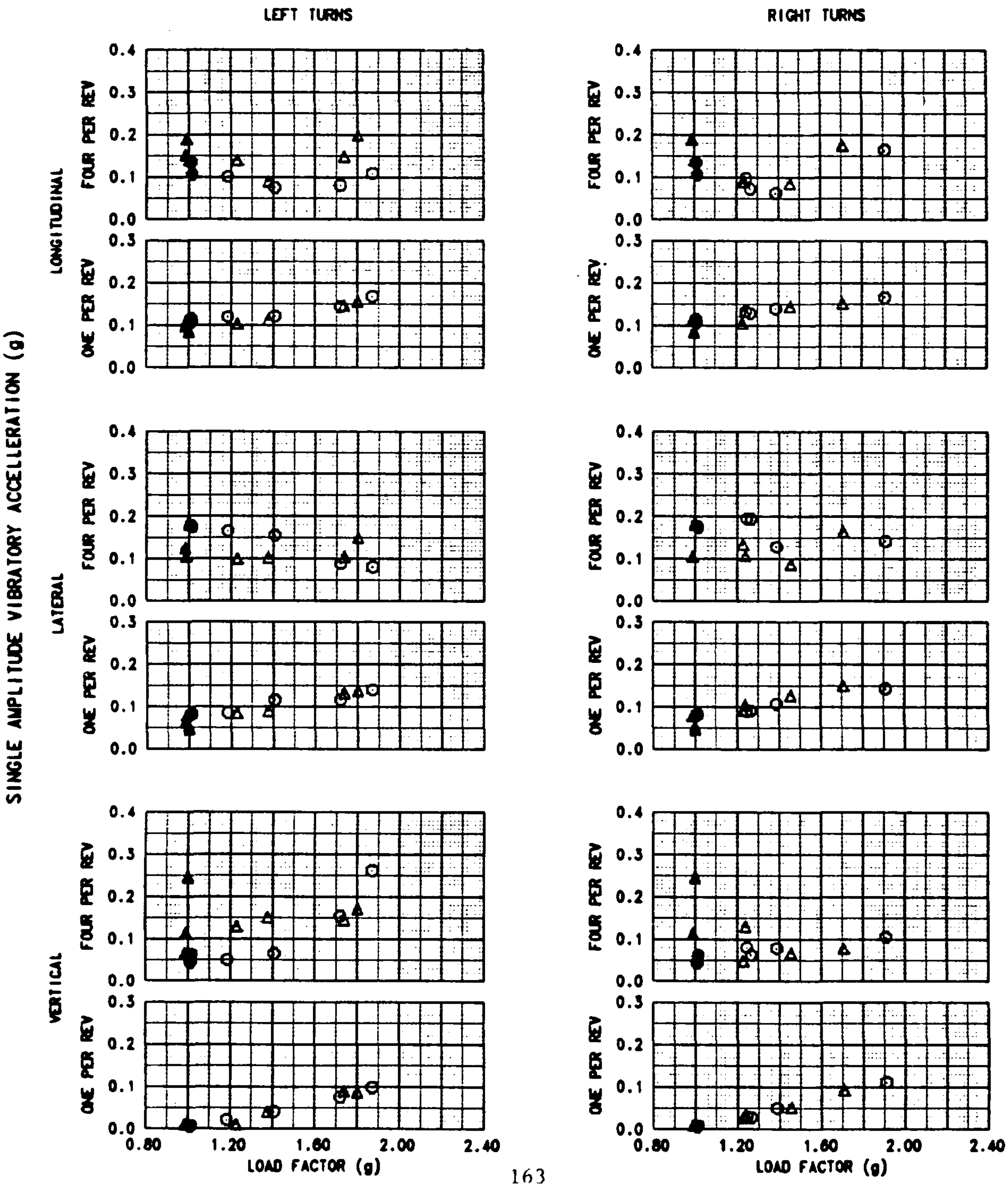


FIGURE E-92
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 150 KCAS
UH-60A USA S/N 82-23748

MAIN ROTOR HUB - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15610	361.2 (AFT)	8820	6.5	254.2	0.007426
△	17200	360.7 (AFT)	8380	1.0	251.1	0.008271

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

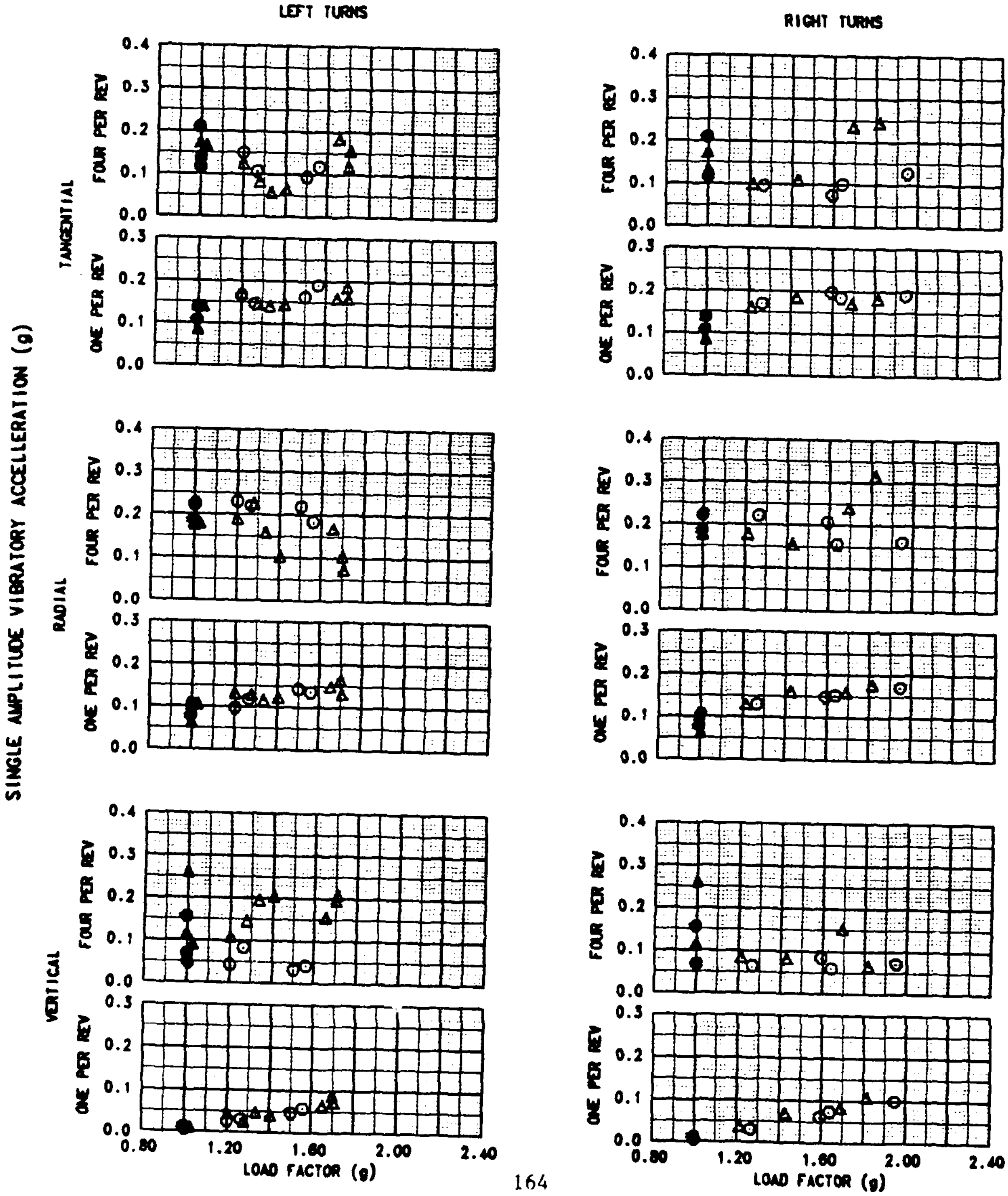


FIGURE E-93
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 160 KCAS
UH-60A USA S/N 82-23748

MAIN ROTOR HUB - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15920	360.7 (AFT)	8600	8.0	255.5	0.007452
△	17100	360.8 (AFT)	9080	4.5	253.0	0.008279

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

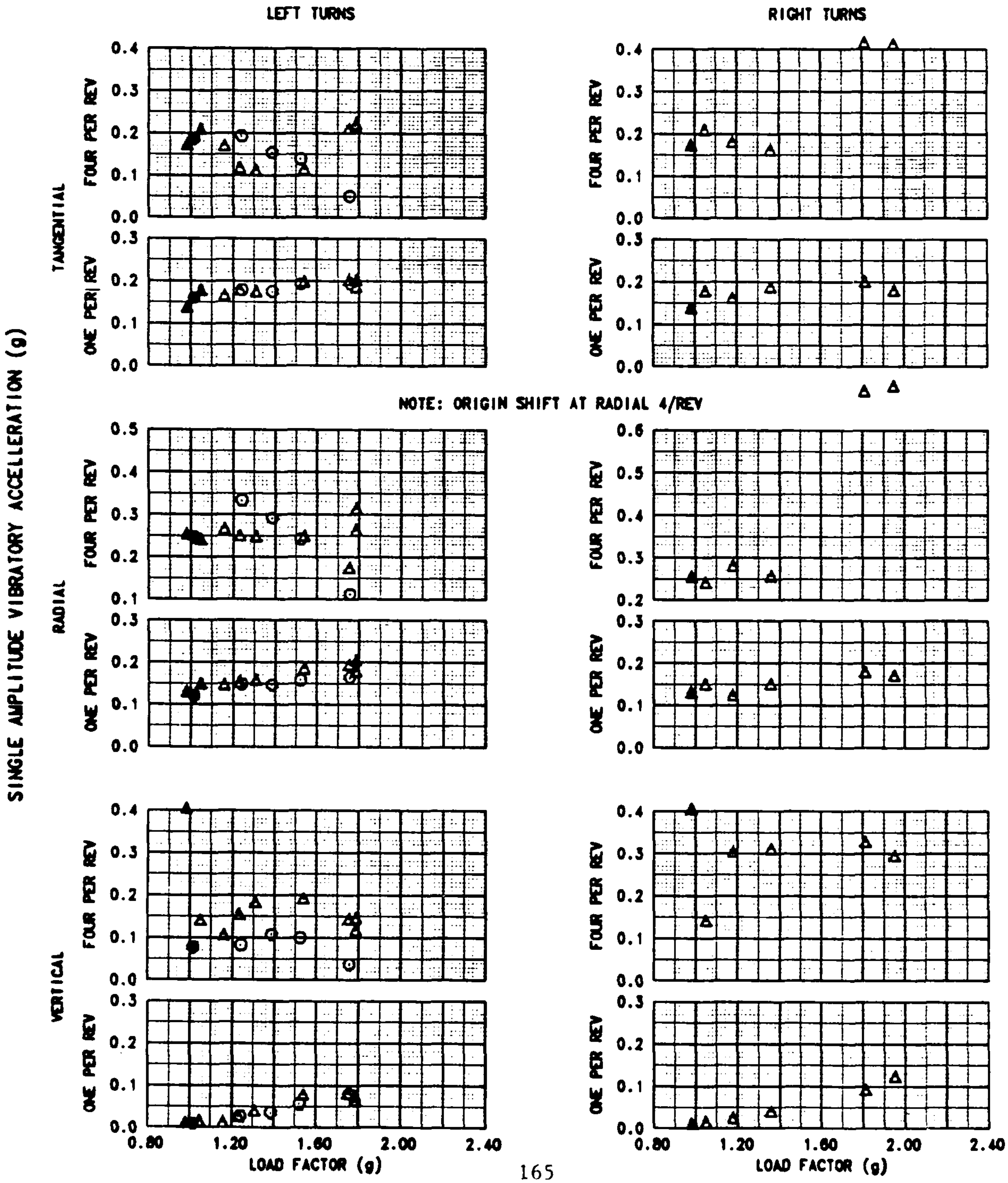


FIGURE E-94
VIBRATION CHARACTERISTICS IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

MAIN ROTOR HUB - STATION FS 253.0 BL 31.0 LT WL 206.7

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15400	361.5 (AFT)	9040	6.6	253.6	0.007388
Δ	17280	361.6 (AFT)	9130	9.0	254.8	0.008260

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT
3. FUNDAMENTAL FREQUENCY AT 258 RPM = 4.3 Hz

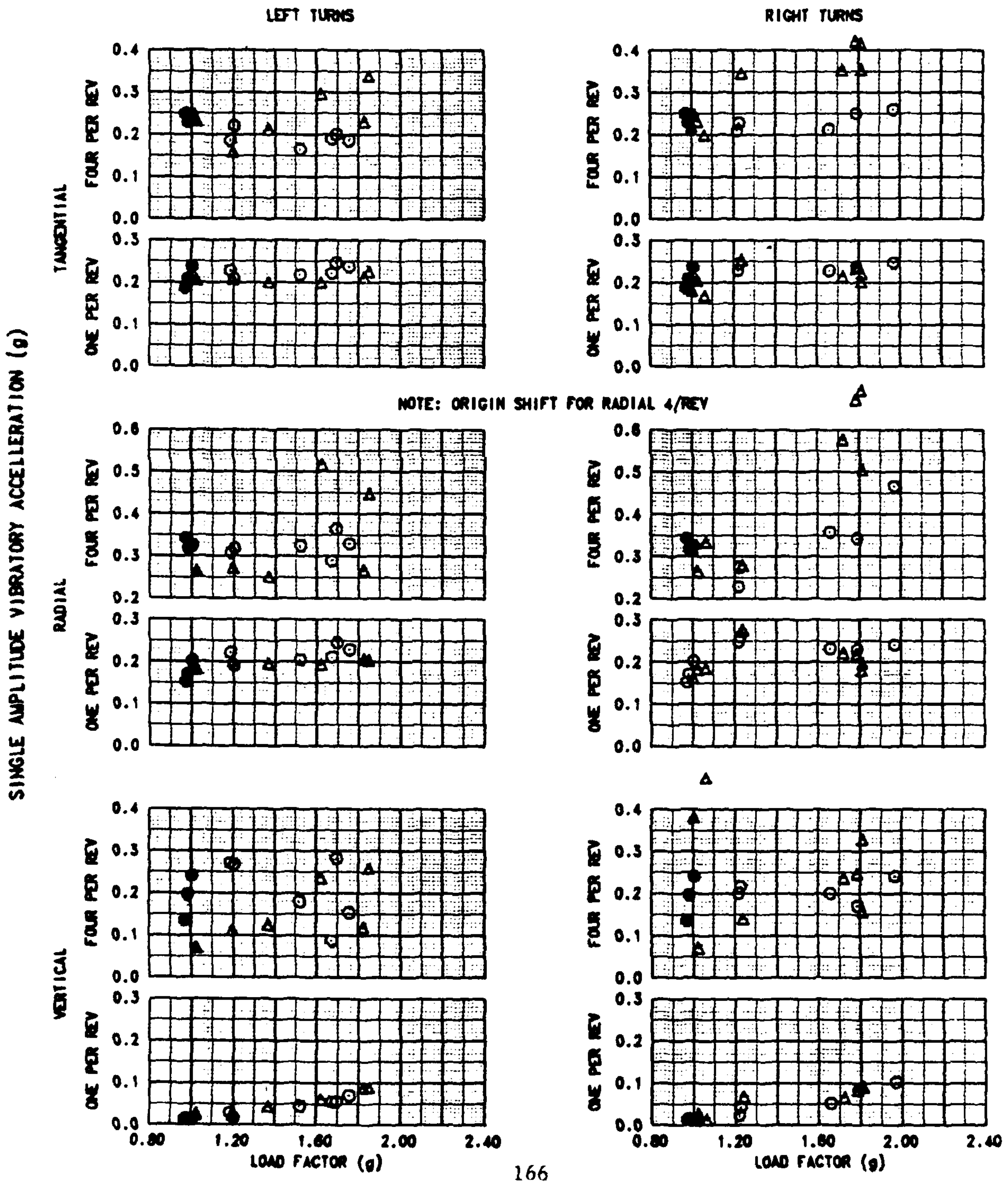


FIGURE E-95
MAIN ROTOR PITCH CHANGE LINK LOAD
AND SHAFT EXTENSION BENDING MOMENT IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15560	361.0(AFT)	5975	12.5	256.9	0.006595
○	17080	360.8(AFT)	6983	14.0	257.5	0.007465
△	19040	360.5(AFT)	6900	15.5	258.5	0.008252

NOTE: SOME DATA NOT AVAILABLE BECAUSE OF INSTRUMENTATION FAILURE

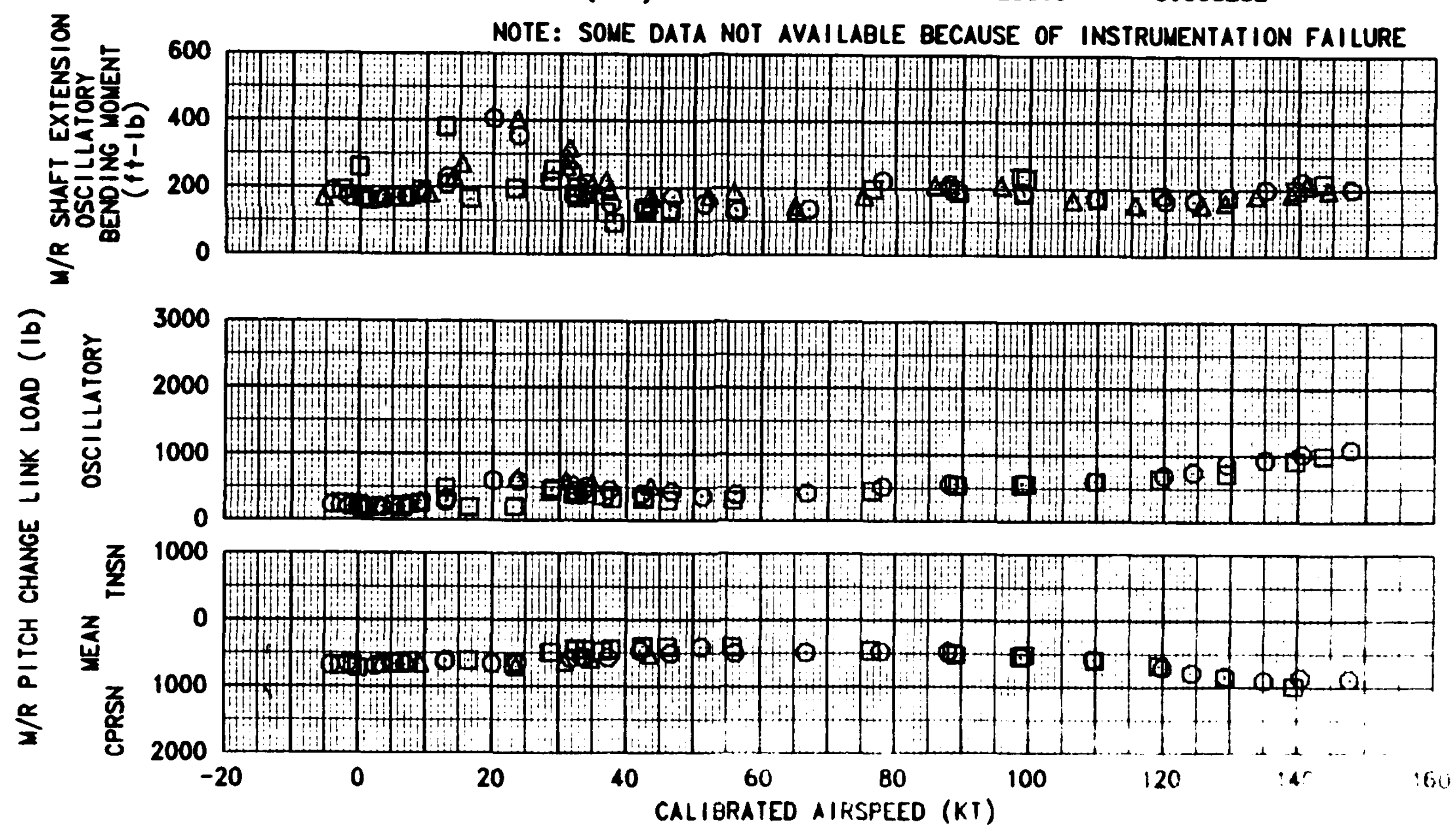


FIGURE E-96

MAIN ROTOR PITCH CHANGE LINK LOAD
AND SHAFT EXTENSION BENDING MOMENT IN CLIMBS AND DESCENTS

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	257.3	0.006619
○	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5160	7.0	254.8	0.008209

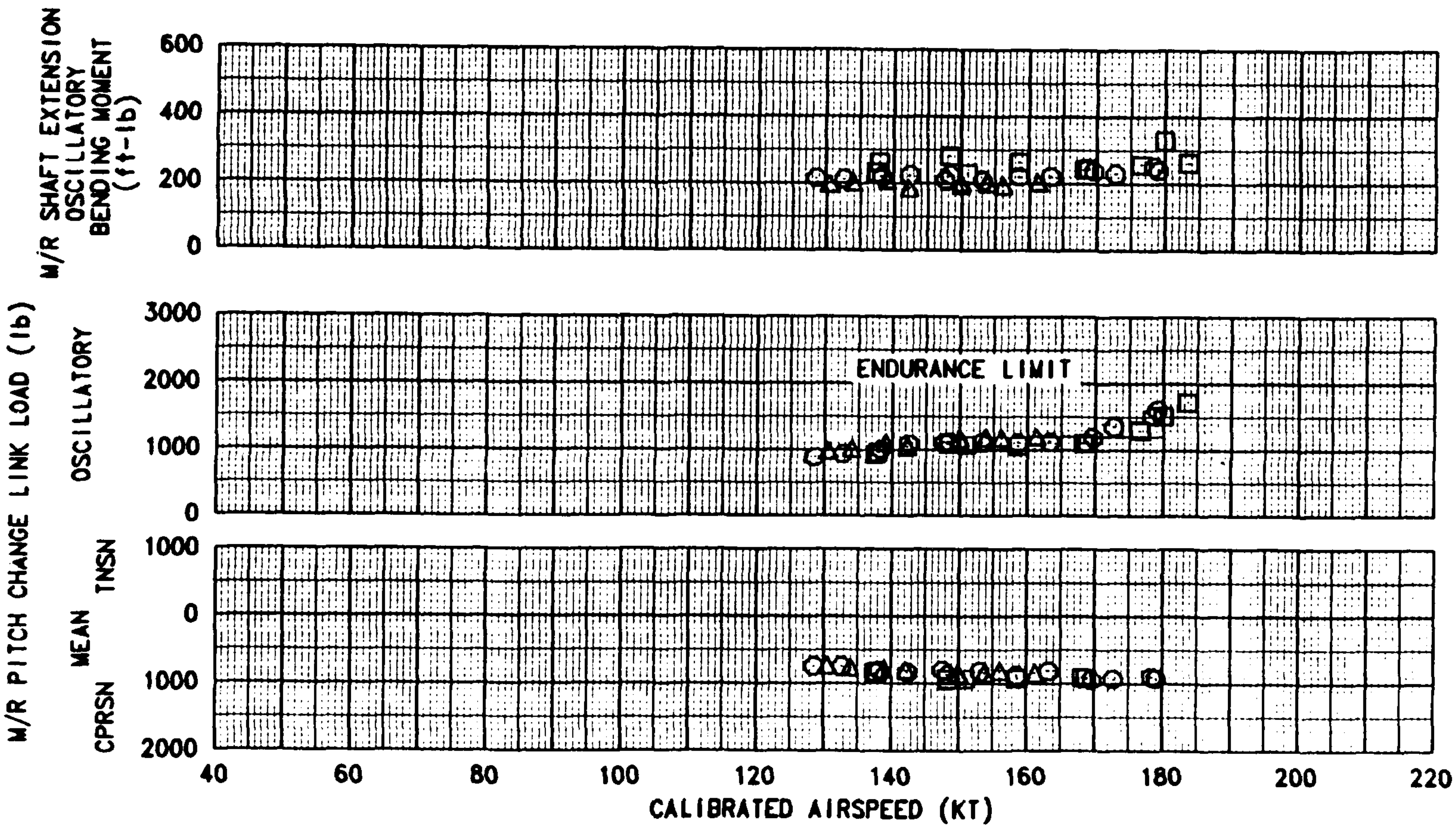


FIGURE E-97
MAIN ROTOR PITCH CHANGE LINK LOAD
AND SHAFT EXTENSION BENDING MOMENT IN TURNING FLIGHT AT 122 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15540	359.9 (AFT)	6160	14.0	258.2	0.006600
○	16140	360.7 (AFT)	8130	8.0	254.7	0.007486
△	17790	360.6 (AFT)	7870	8.5	255.1	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AISPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

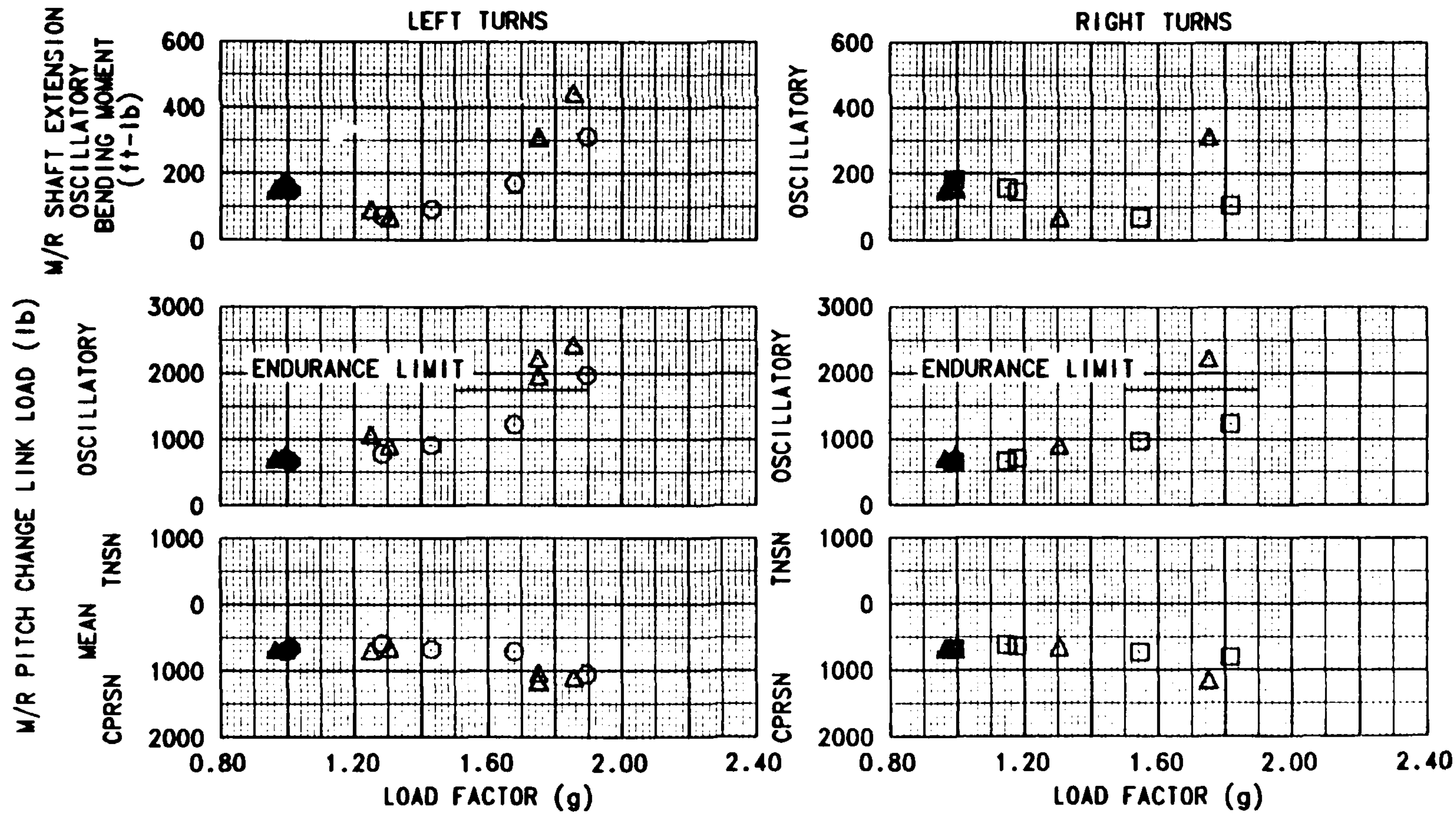


FIGURE E-98
MAIN ROTOR PITCH CHANGE LINK LOAD
AND SHAFT EXTENSION BENDING MOMENT IN TURNING FLIGHT AT 140 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15700	361.1 (AFT)	8850	6.0	254.5	0.007458
△	17570	360.7 (AFT)	8000	3.0	252.6	0.008251

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AISPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

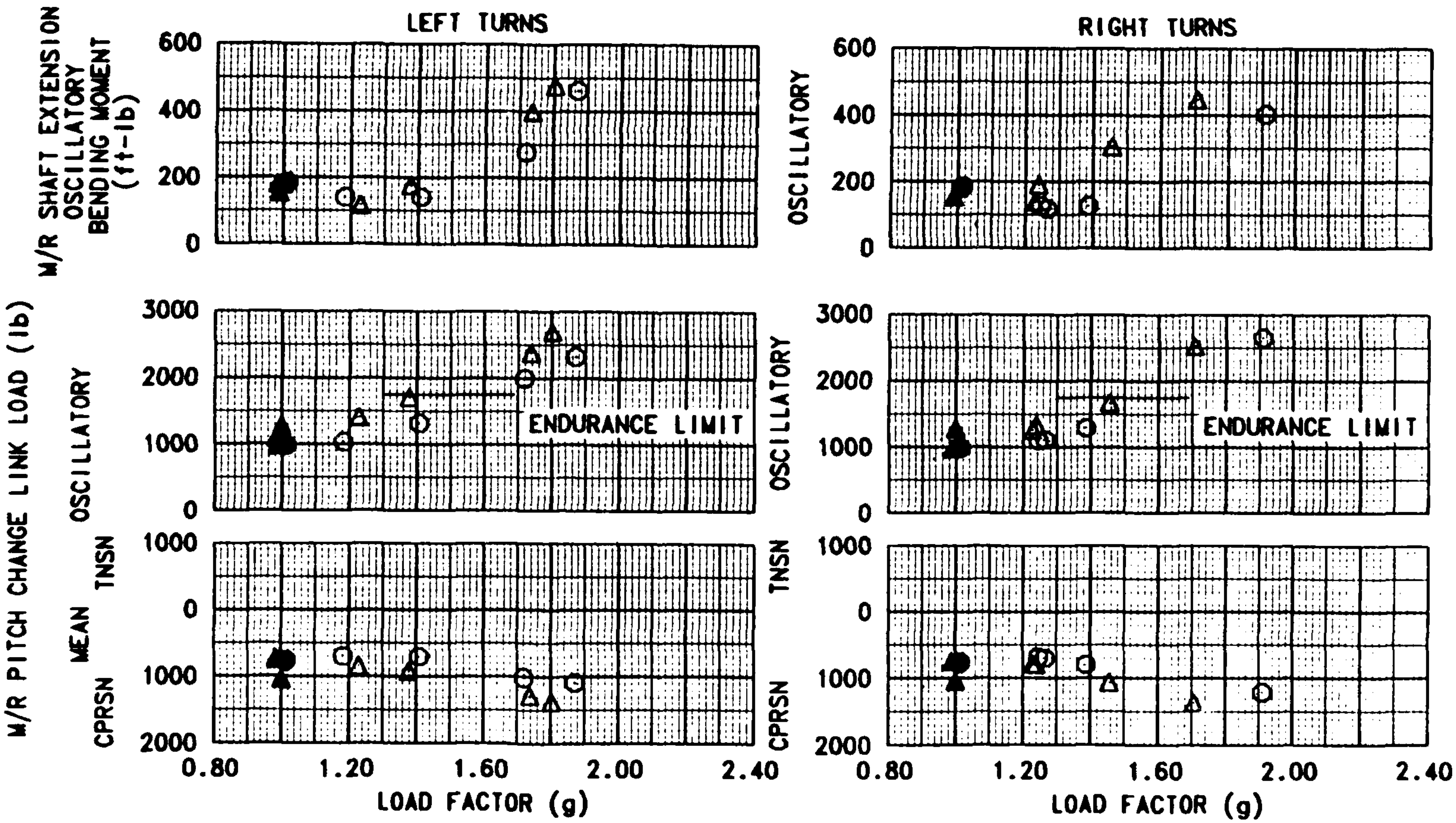


FIGURE E-99
MAIN ROTOR PITCH CHANGE LINK LOAD
AND SHAFT EXTENSION BENDING MOMENT IN TURNING FLIGHT AT 150 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15610	361.2 (AFT)	8820	6.5	254.2	0.007426
Δ	17200	360.7 (AFT)	8380	1.0	251.1	0.008271

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AISPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

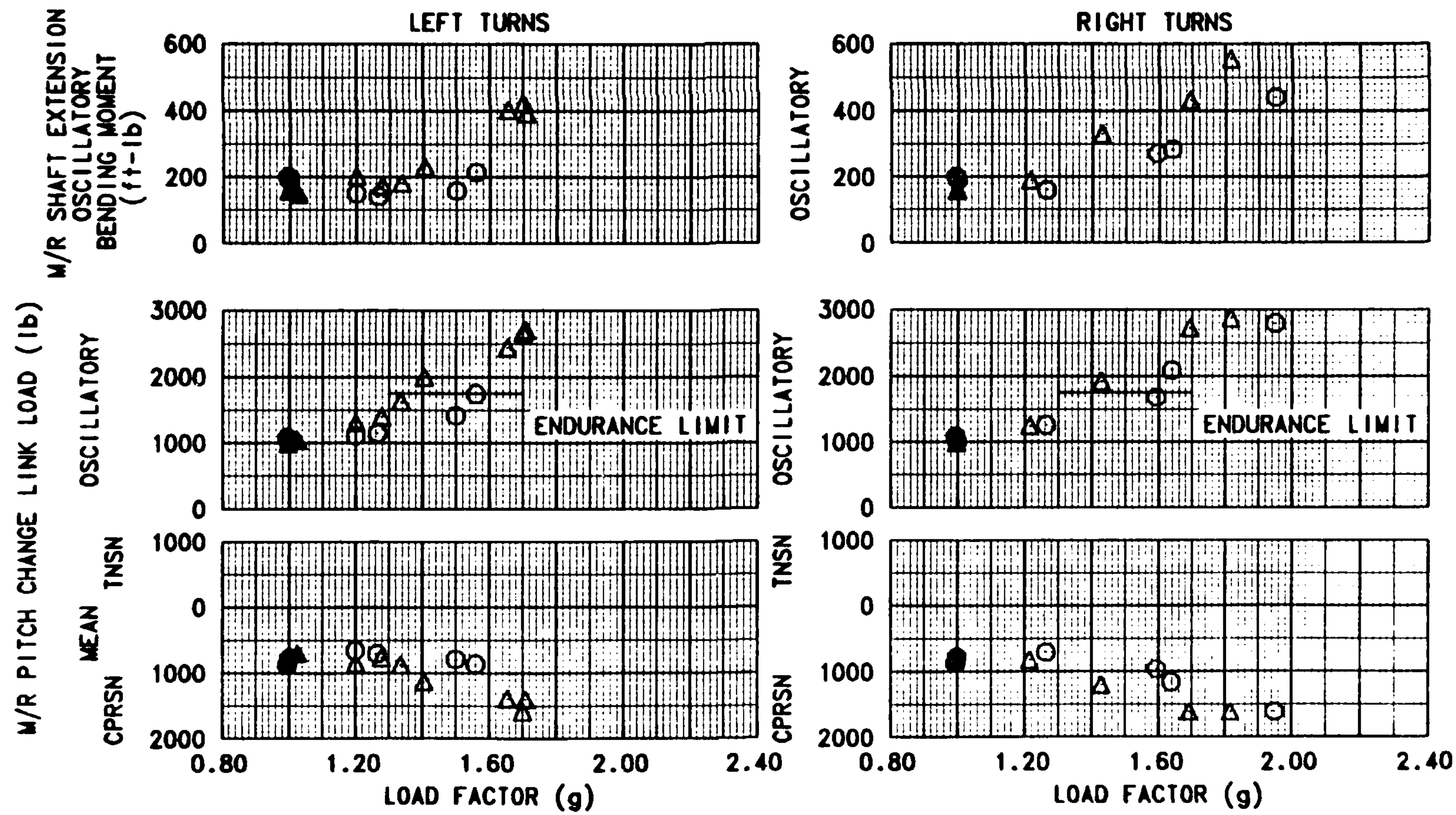


FIGURE E-100
MAIN ROTOR PITCH CHANGE LINK LOAD
AND SHAFT EXTENSION BENDING MOMENT IN TURNING FLIGHT AT 160 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15920	360.7 (AFT)	8600	8.0	255.5	0.007451
△	17100	360.8 (AFT)	9080	4.5	253.0	0.008279

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AISPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

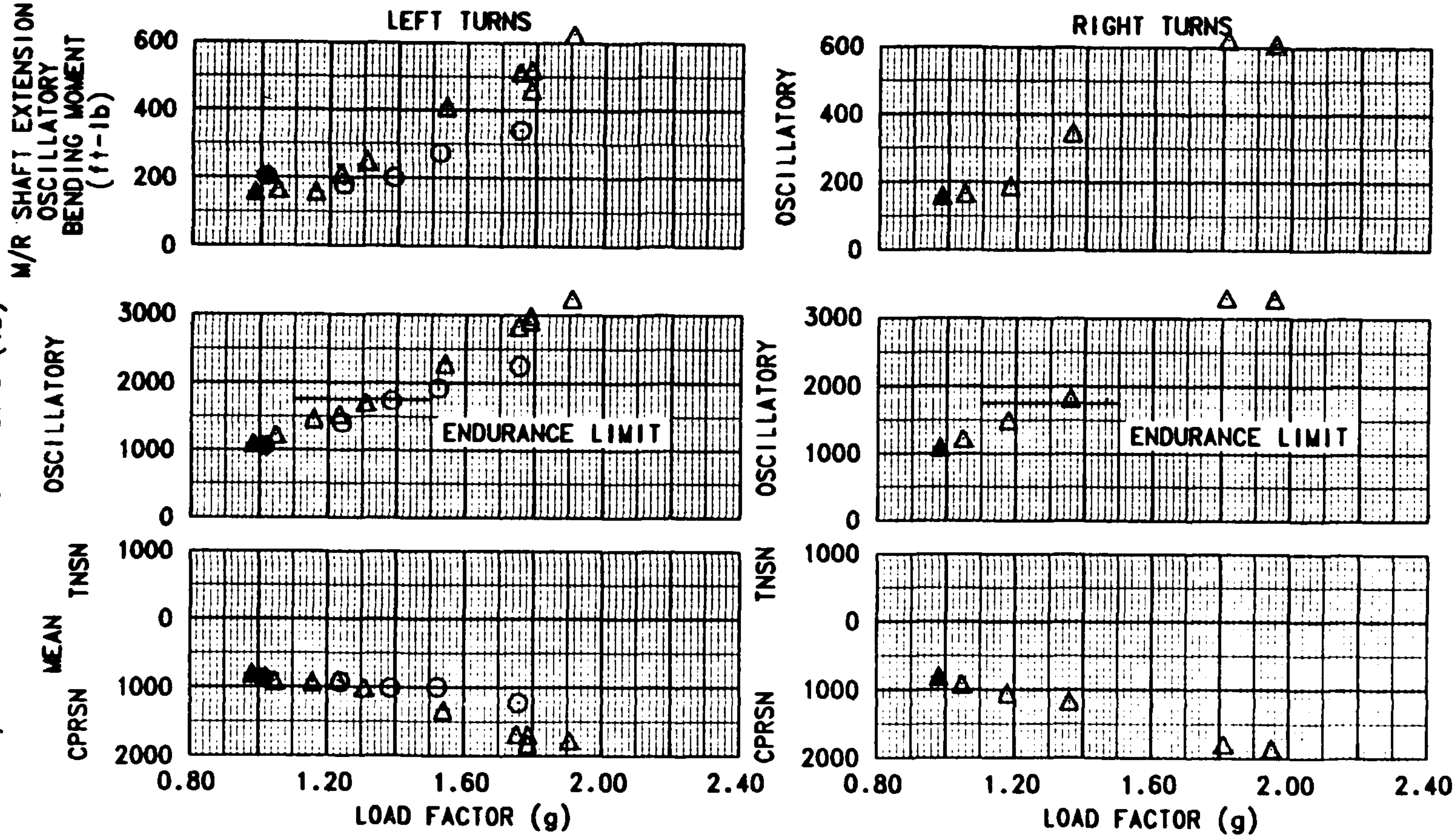


FIGURE E-101
MAIN ROTOR PITCH CHANGE LINK LOAD
AND SHAFT EXTENSION BENDING MOMENT IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15400	361.5 (AFT)	9040	6.6	253.6	0.007388
△	17280	361.6 (AFT)	9130	9.0	254.8	0.008260

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AISPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

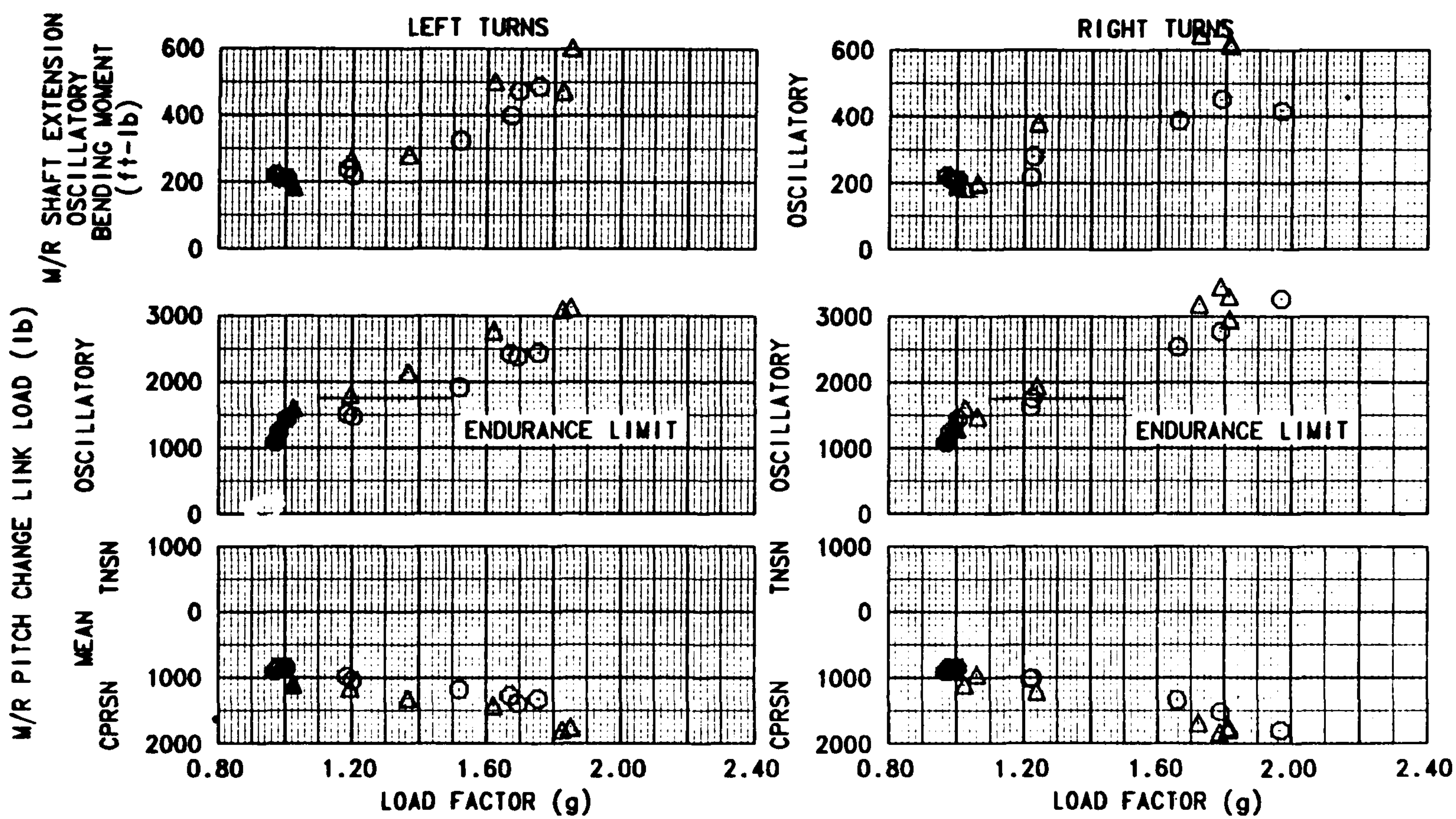


FIGURE E-102

MAIN ROTOR STATIONARY SWASHPLATE LINK LOADS IN LEVEL FLIGHT

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15560	361.0(AFT)	5750	12.5	258.5	0.006595
○	17080	360.8(AFT)	6930	14.0	258.2	0.007465
△	19040	360.5(AFT)	6900	15.5	258.5	0.008252

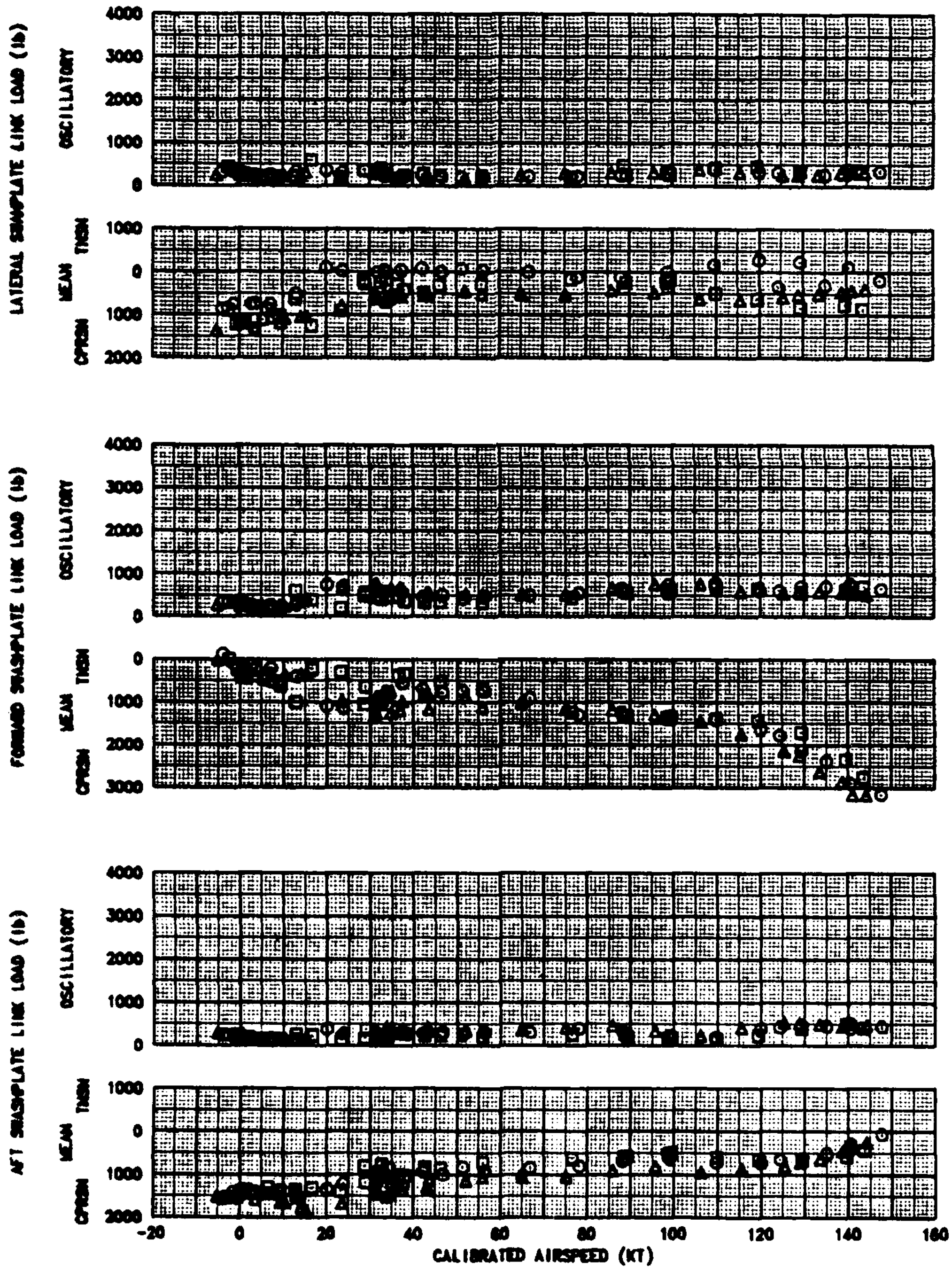


FIGURE E-103
MAIN ROTOR STATIONARY SWASHPLATE LINK LOADS IN CLIMBS AND POWERED DESCENTS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	257.3	0.006619
⊙	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5160	7.0	254.8	0.008209

NOTES: 1. SHADED SYMBOL DENOTES LEVEL FLIGHT
2. DATA OBTAINED USING INTERMEDIATE RATED POWER

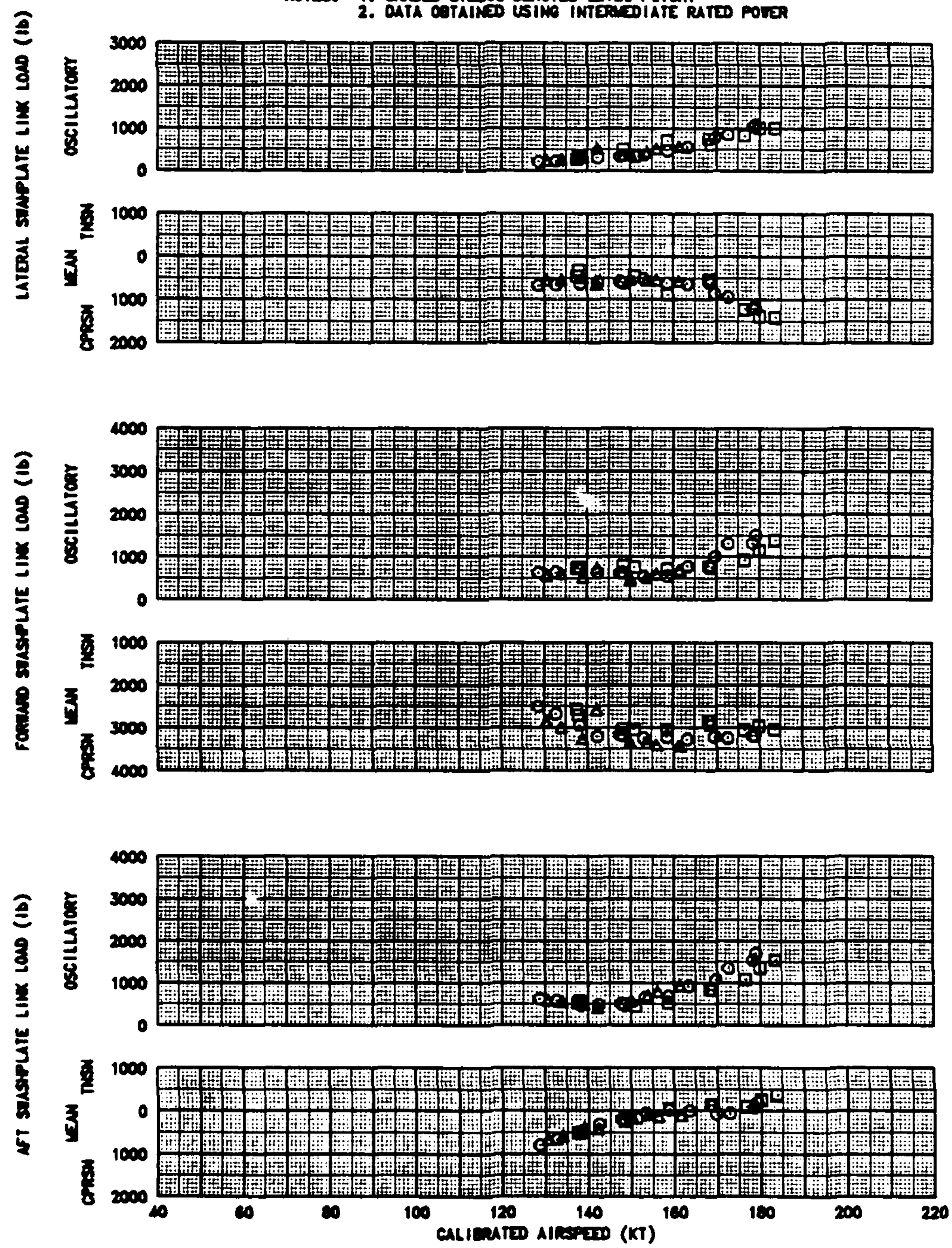


FIGURE E-104
MAIN ROTOR STATIONARY SWASHPLATE LINK LOADS IN TURNING FLIGHT AT 122 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15540	359.9 (AFT)	6160	14.0	258.2	0.006600
○	16140	360.7 (AFT)	8130	8.0	254.7	0.007488
△	17790	360.6 (AFT)	7870	8.5	255.1	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AISPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

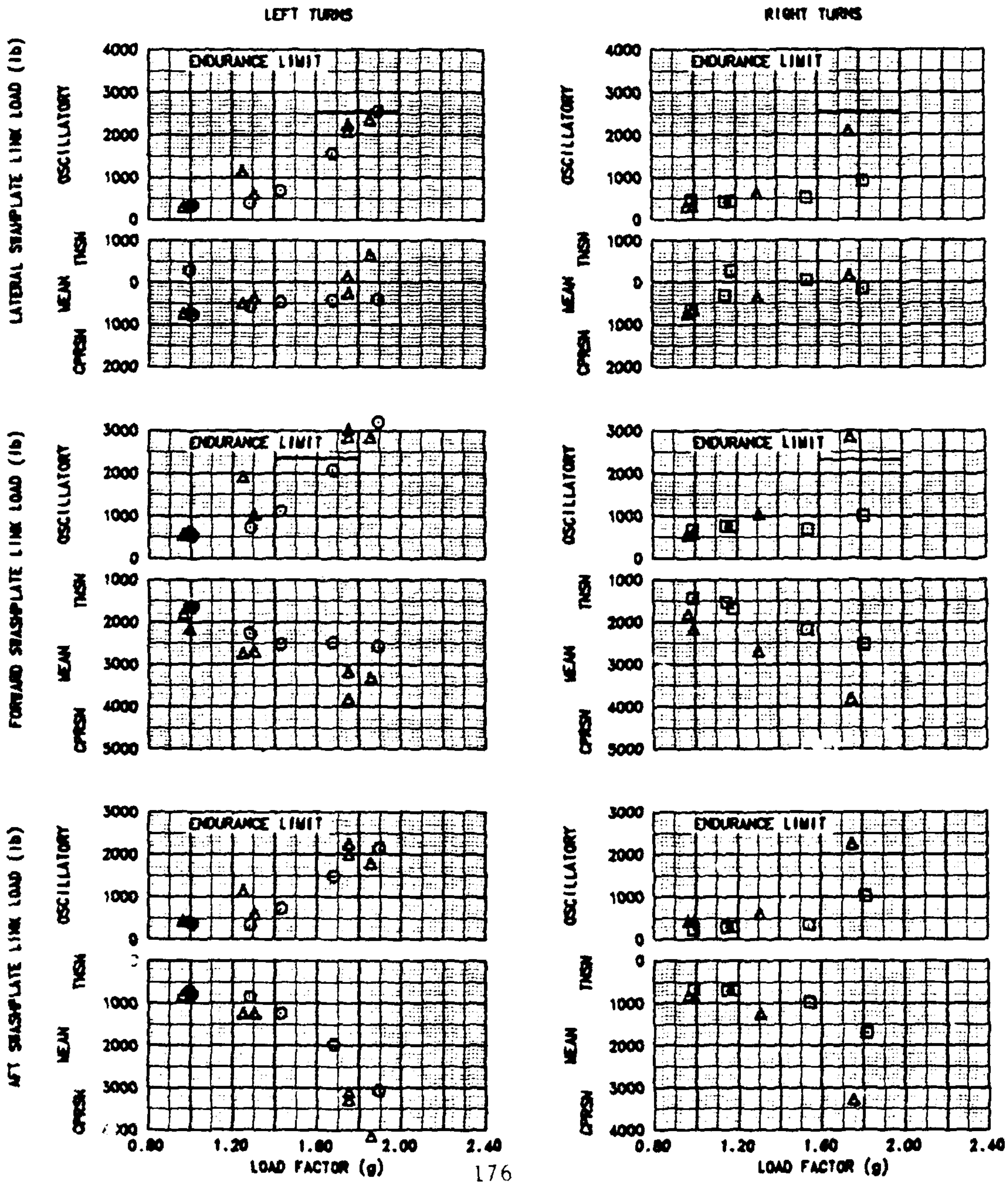


FIGURE E-105
MAIN ROTOR STATIONARY SWASHPLATE LINK LOADS IN TURNING FLIGHT AT 140 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15700	381.1 (AFT)	8850	6.0	254.5	0.007458
△	17570	360.7 (AFT)	8000	3.0	252.6	0.008251

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

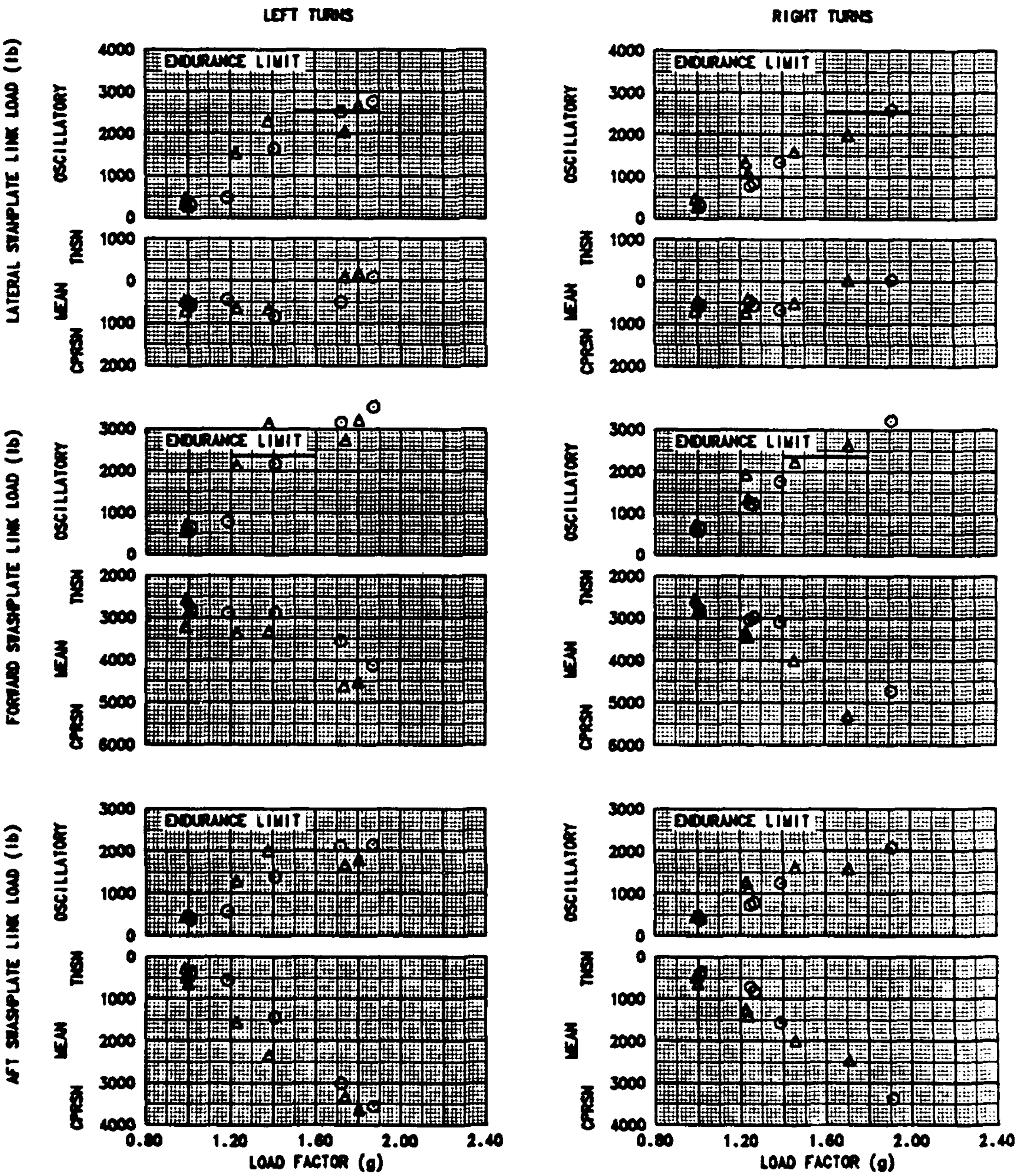


FIGURE E-108

MAIN ROTOR STATIONARY SWASHPLATE LINK LOADS IN TURNING FLIGHT AT 150 KCAS

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15610	361.2 (AFT)	8820	6.5	254.2	0.007426
△	17200	360.7 (AFT)	8380	1.0	251.1	0.008271

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

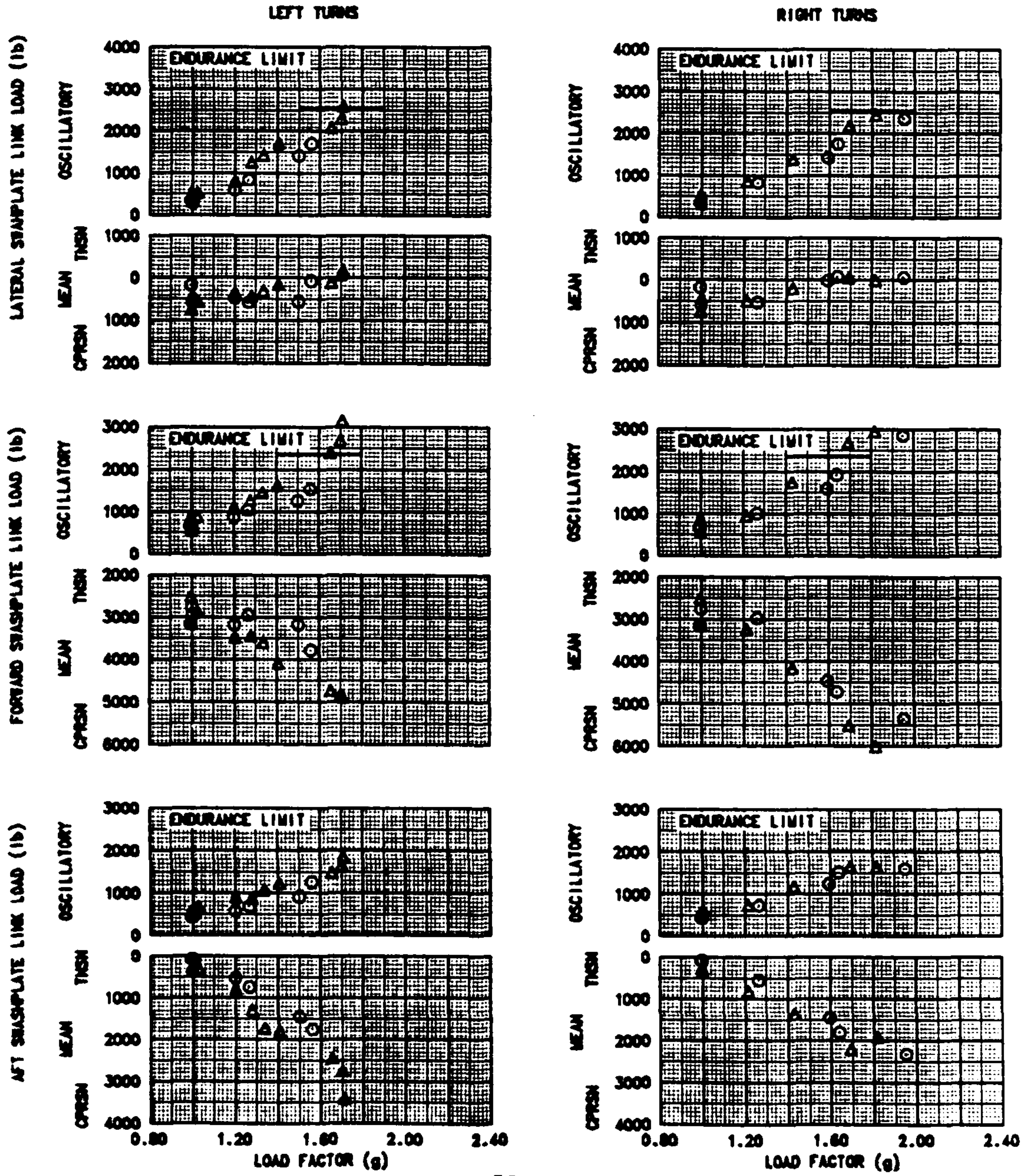


FIGURE E-107
MAIN ROTOR SWASHPLATE LINK LOADS IN TURNING FLIGHT AT 160 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15920	360.7 (AFT)	8600	8.0	255.5	0.007451
△	17100	360.8 (AFT)	9080	4.5	253.8	0.008279

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

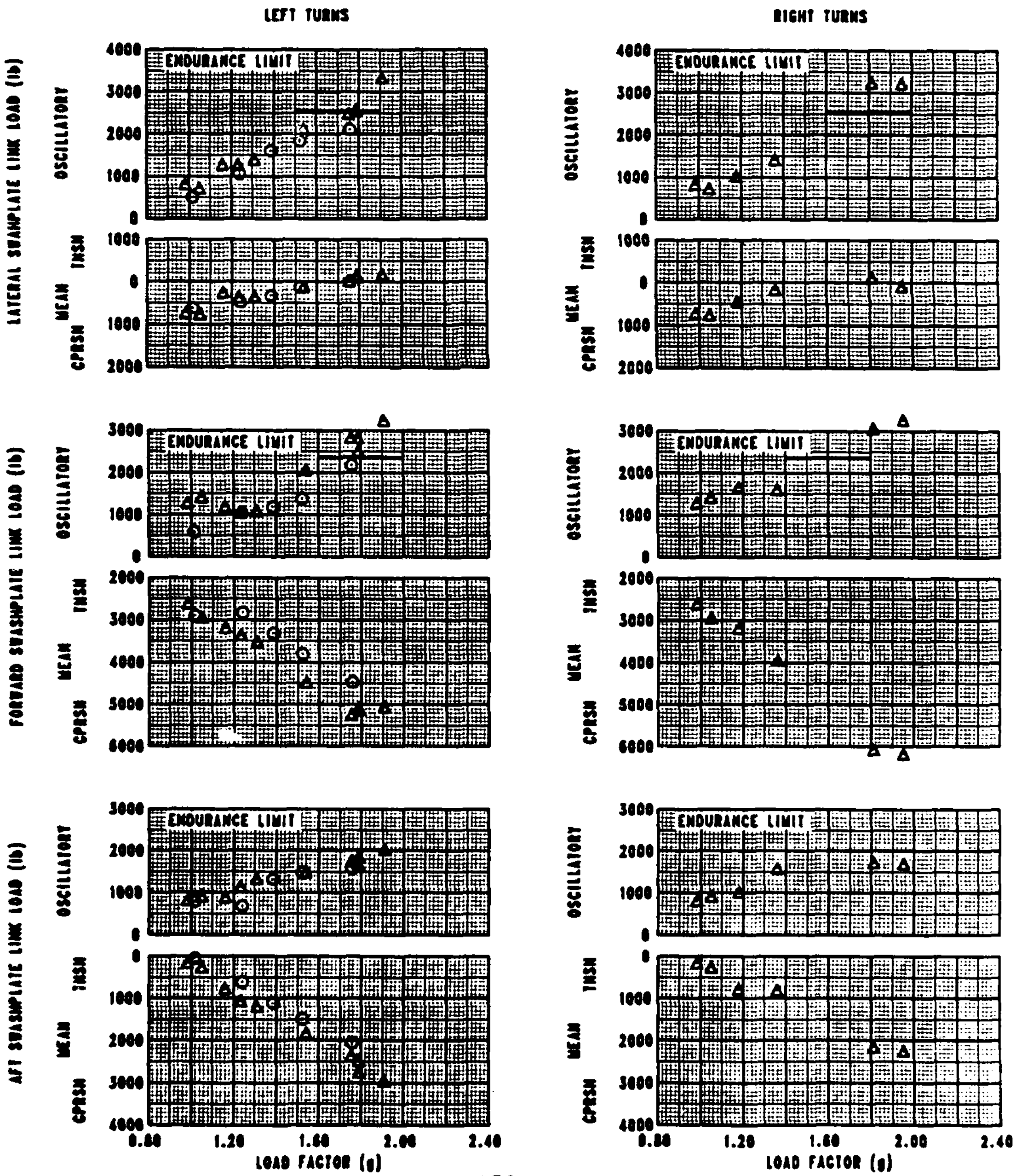


FIGURE 108
MAIN ROTOR SWASHPLATE LINK LOADS IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
⊙	15400	361.5 (AFT)	9040	6.6	253.6	0.007388
Δ	17280	361.6 (AFT)	9130	9.0	254.8	0.008280

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

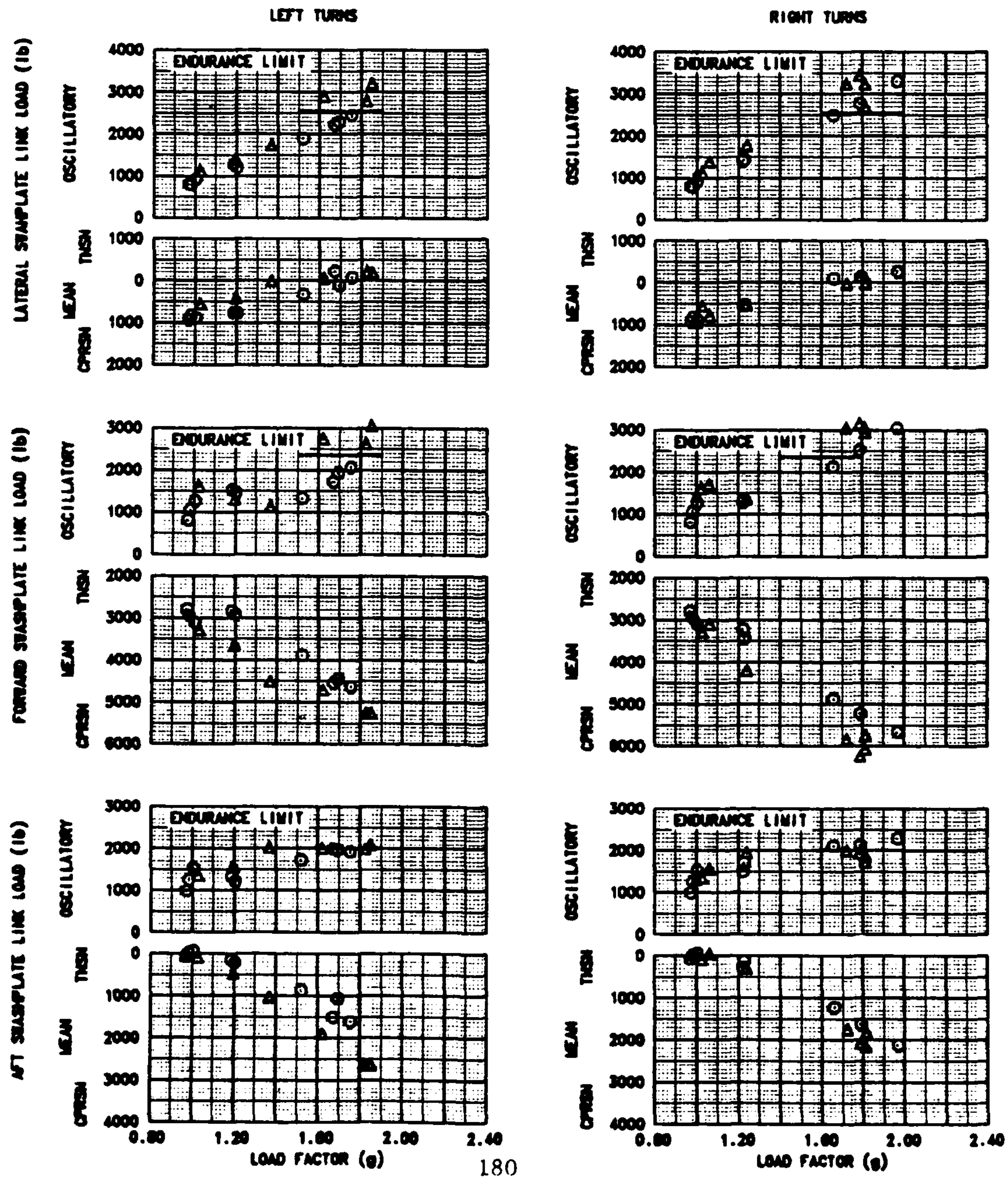


FIGURE E-109
MAIN ROTOR SPAR NORMAL BENDING LOADS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15560	361.0(AFT)	5750	12.5	258.5	0.006595
⊙	17080	360.8(AFT)	6930	14.0	258.2	0.007465
△	19040	360.5(AFT)	6900	15.5	258.5	0.008252

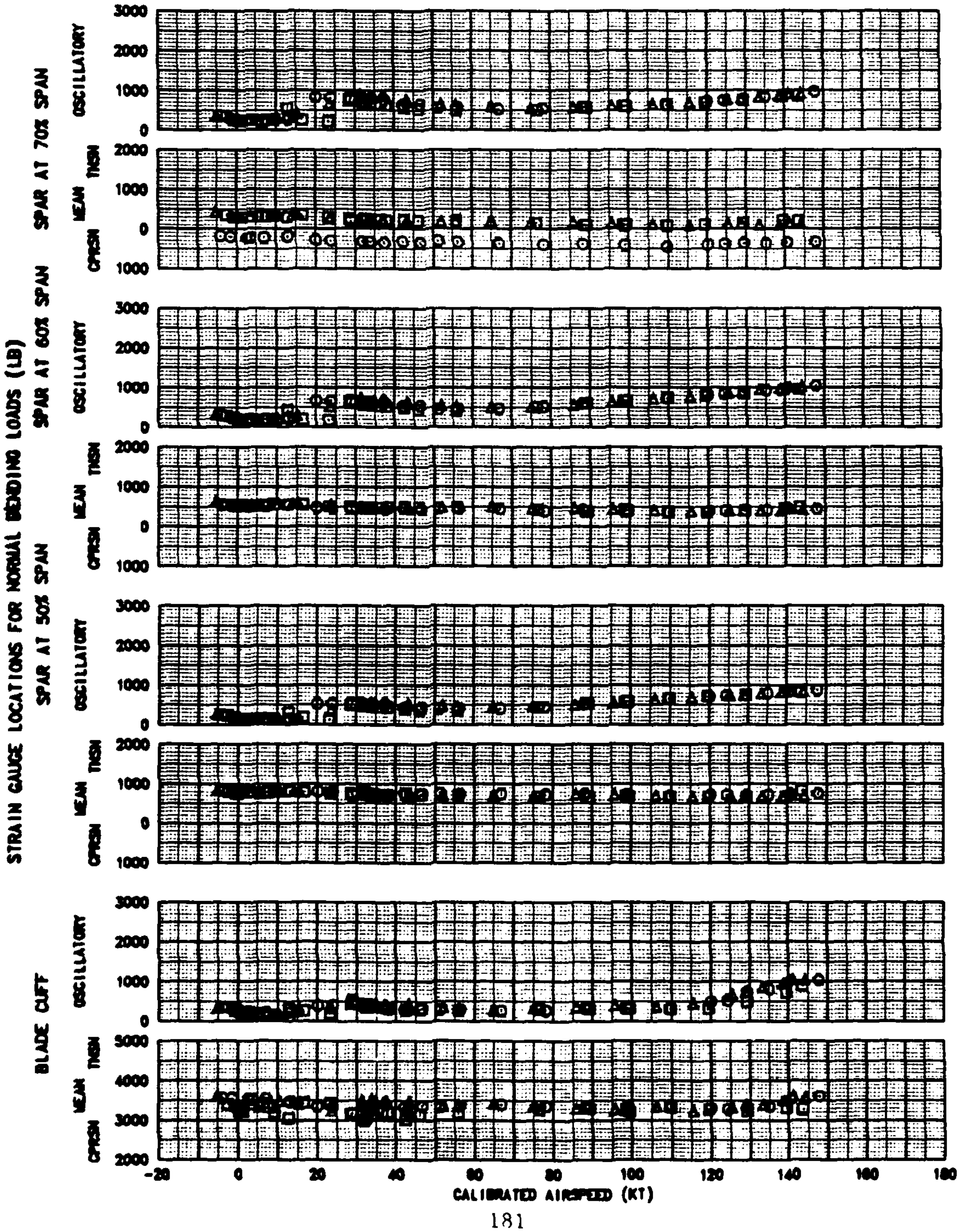


FIGURE E-110
MAIN ROTOR SPAR NORMAL BENDING LOADS IN CLIMBS AND POWERED DESCENTS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	257.3	0.006619
○	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5160	7.0	254.8	0.008209

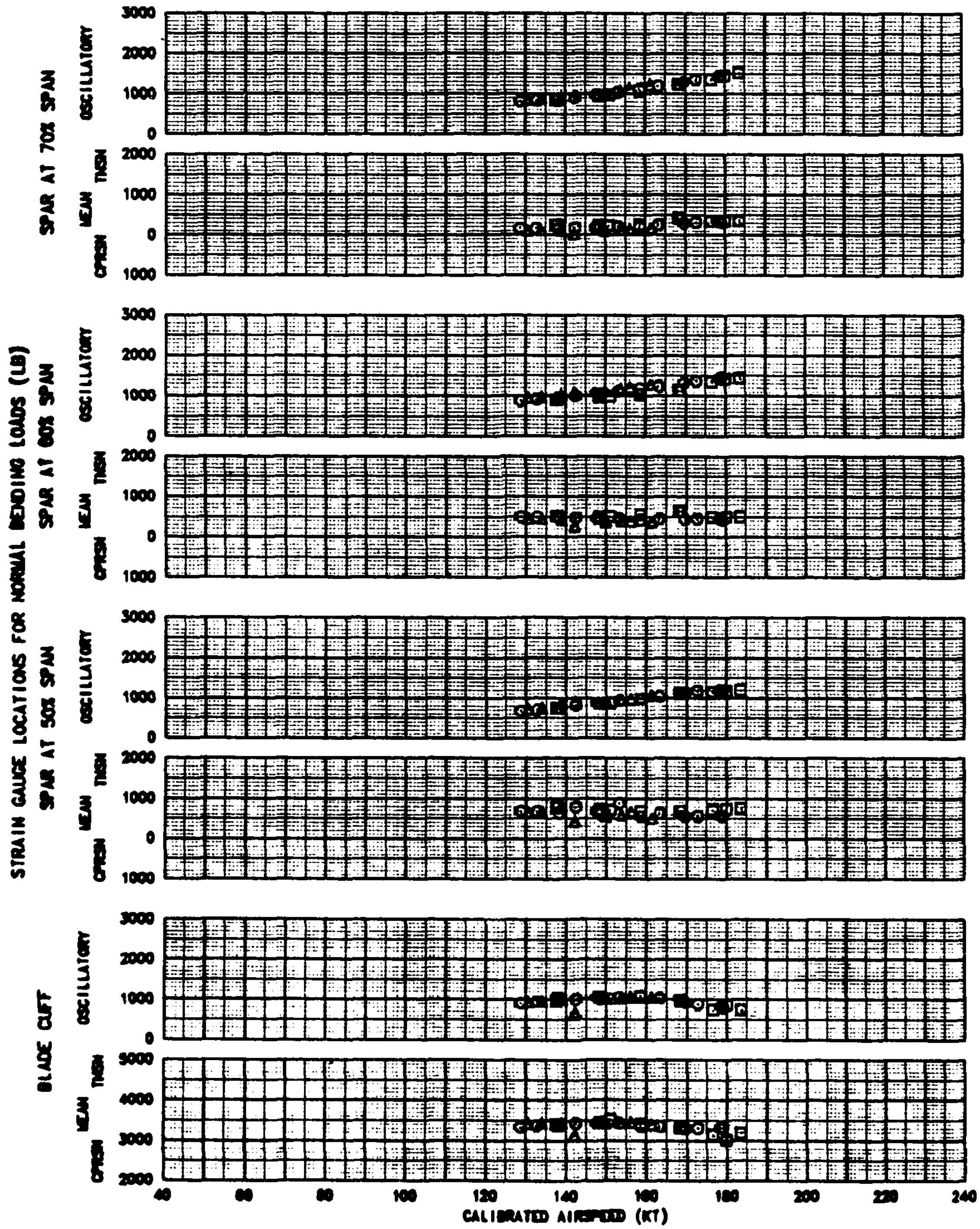


FIGURE E-111

MAIN ROTOR SPAR NORMAL BENDING LOADS IN TURNING FLIGHT AT 122 KCAS

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15540	359.9 (AFT)	6160	14.0	258.2	0.006600
○	16140	360.7 (AFT)	6130	8.0	254.7	0.007488
△	17790	360.6 (AFT)	7900	8.5	255.1	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

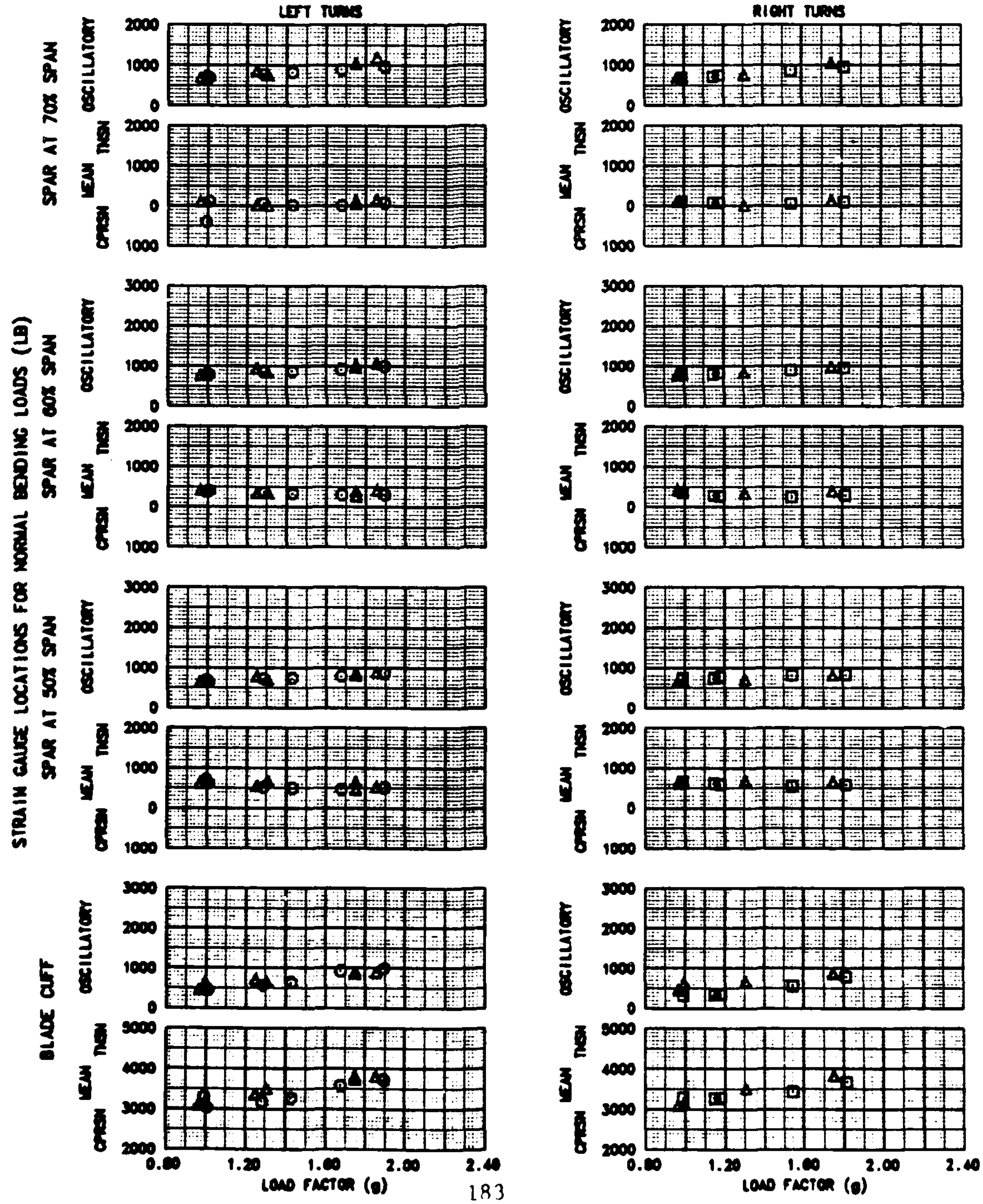


FIGURE E-112
MAIN ROTOR SPAR NORMAL BENDING LOADS IN TURNING FLIGHT AT 140 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15700	361.1 (AFT)	8830	6.0	254.5	0.007458
△	17570	360.7 (AFT)	8000	3.0	252.6	0.008251

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

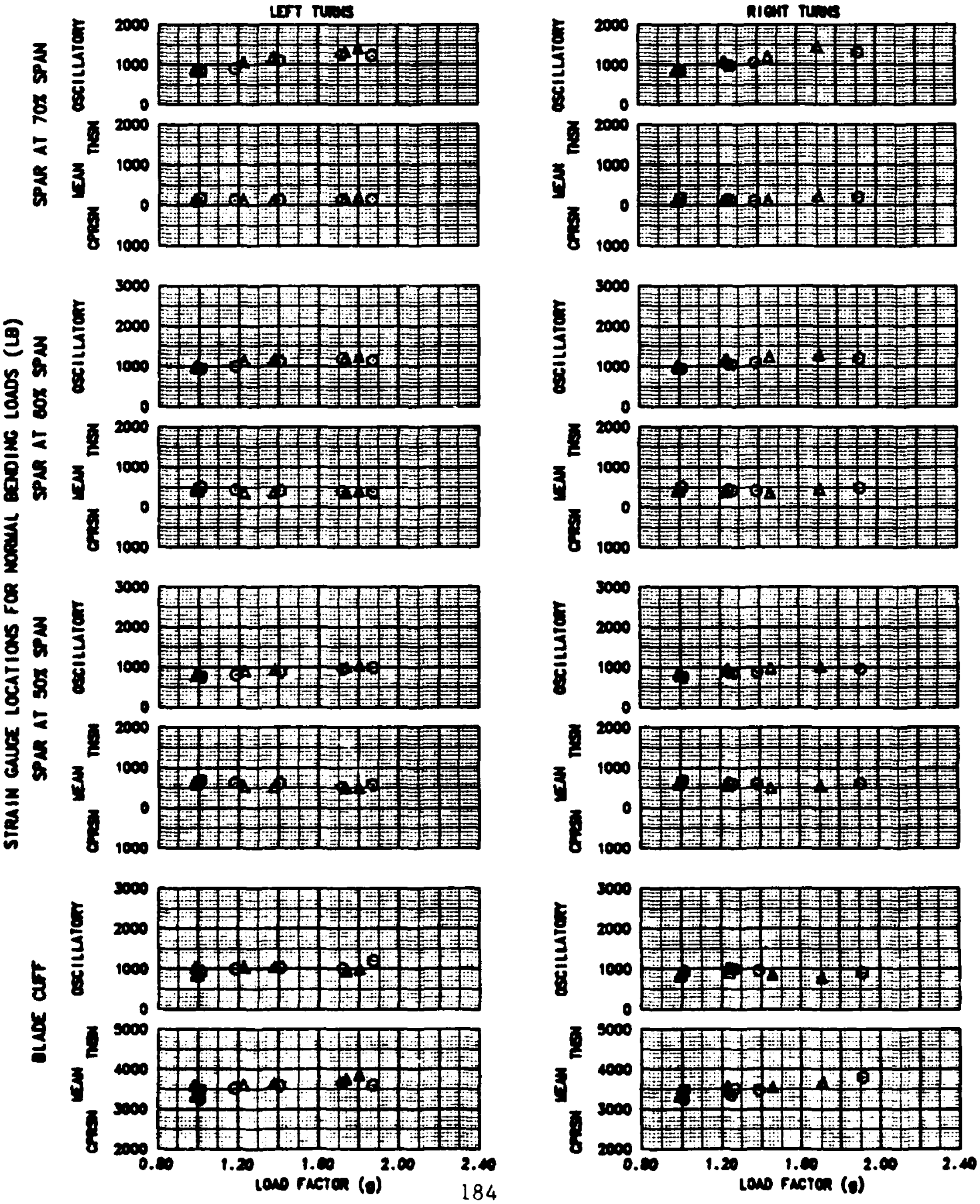


FIGURE E-113
MAIN ROTOR SPAR NORMAL BENDING LOADS IN TURNING FLIGHT AT 150 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15610	361.2 (AFT)	8820	6.5	254.2	0.007426
△	17200	360.7 (AFT)	8380	1.0	251.1	0.008271

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

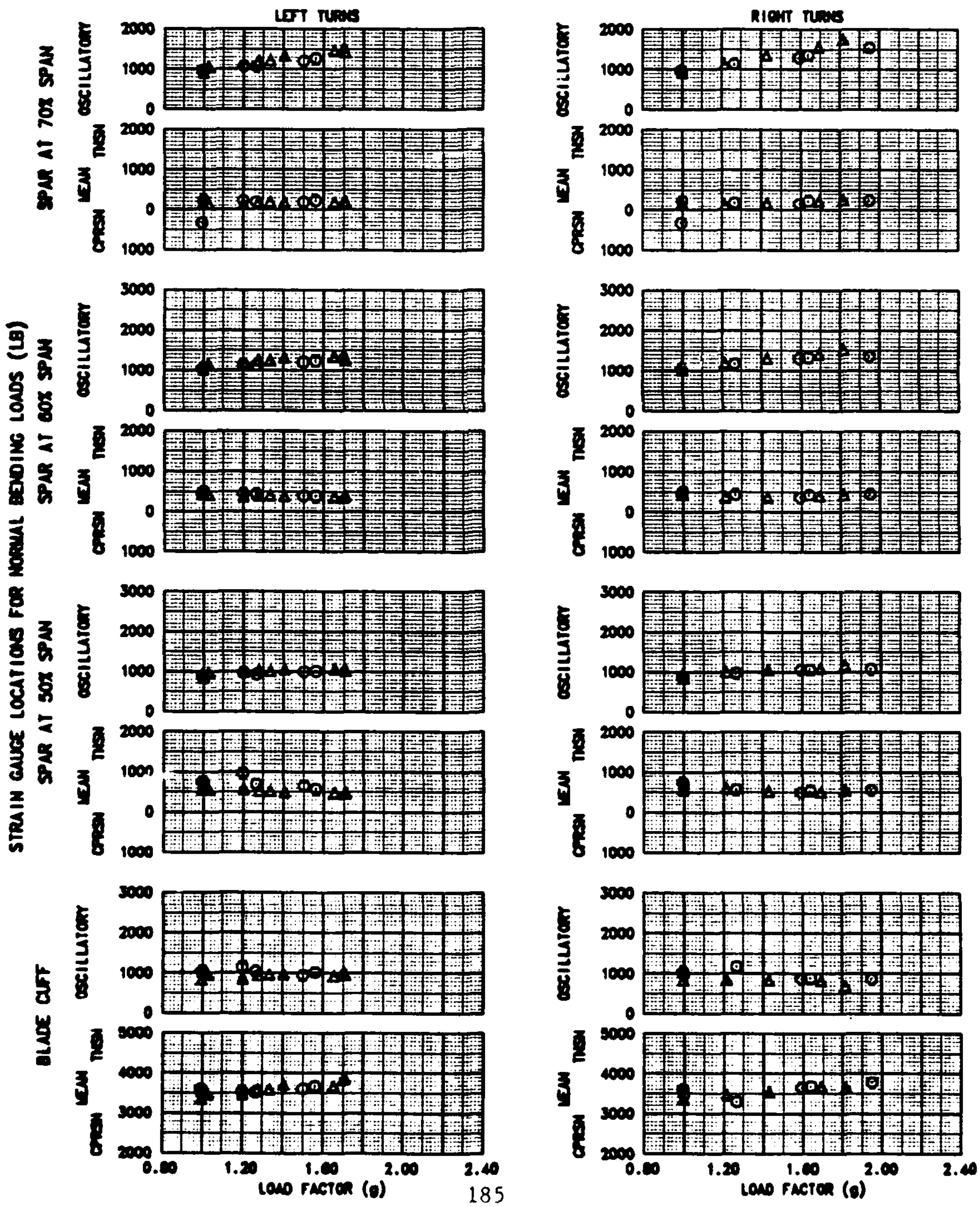


FIGURE E-114
MAIN ROTOR SPAR NORMAL BENDING LOADS IN TURNING FLIGHT AT 160 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15920	360.7 (AFT)	8600	8.0	255.5	0.007451
△	17100	360.8 (AFT)	[illegible]	4.5	253.0	0.008279

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

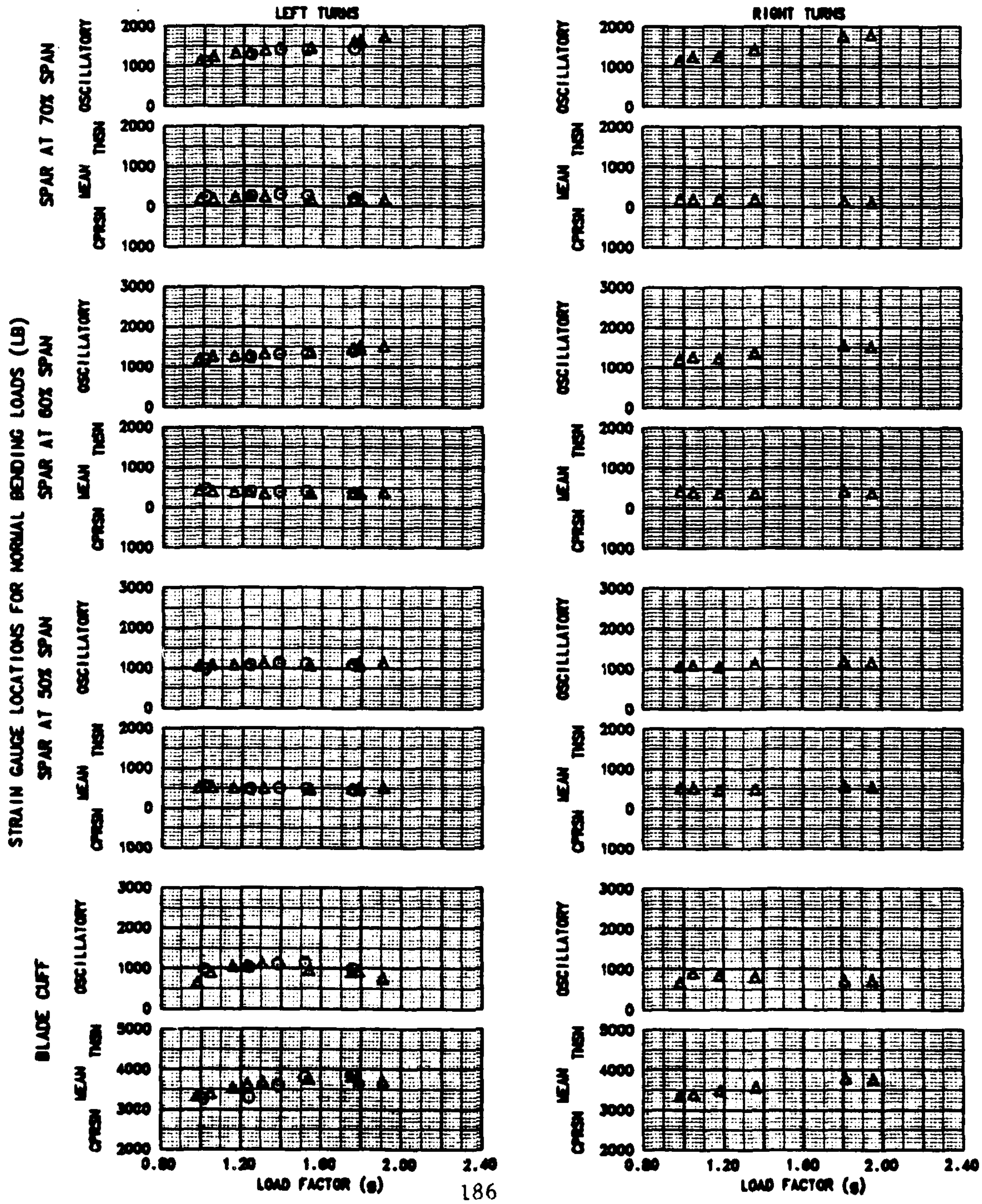


FIGURE E-115
MAIN ROTOR SPAR NORMAL BENDING LOADS IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15400	361.5 (AFT)	9040	6.6	253.6	0.007388
△	17280	361.6 (AFT)	9130	9.0	254.8	0.008280

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

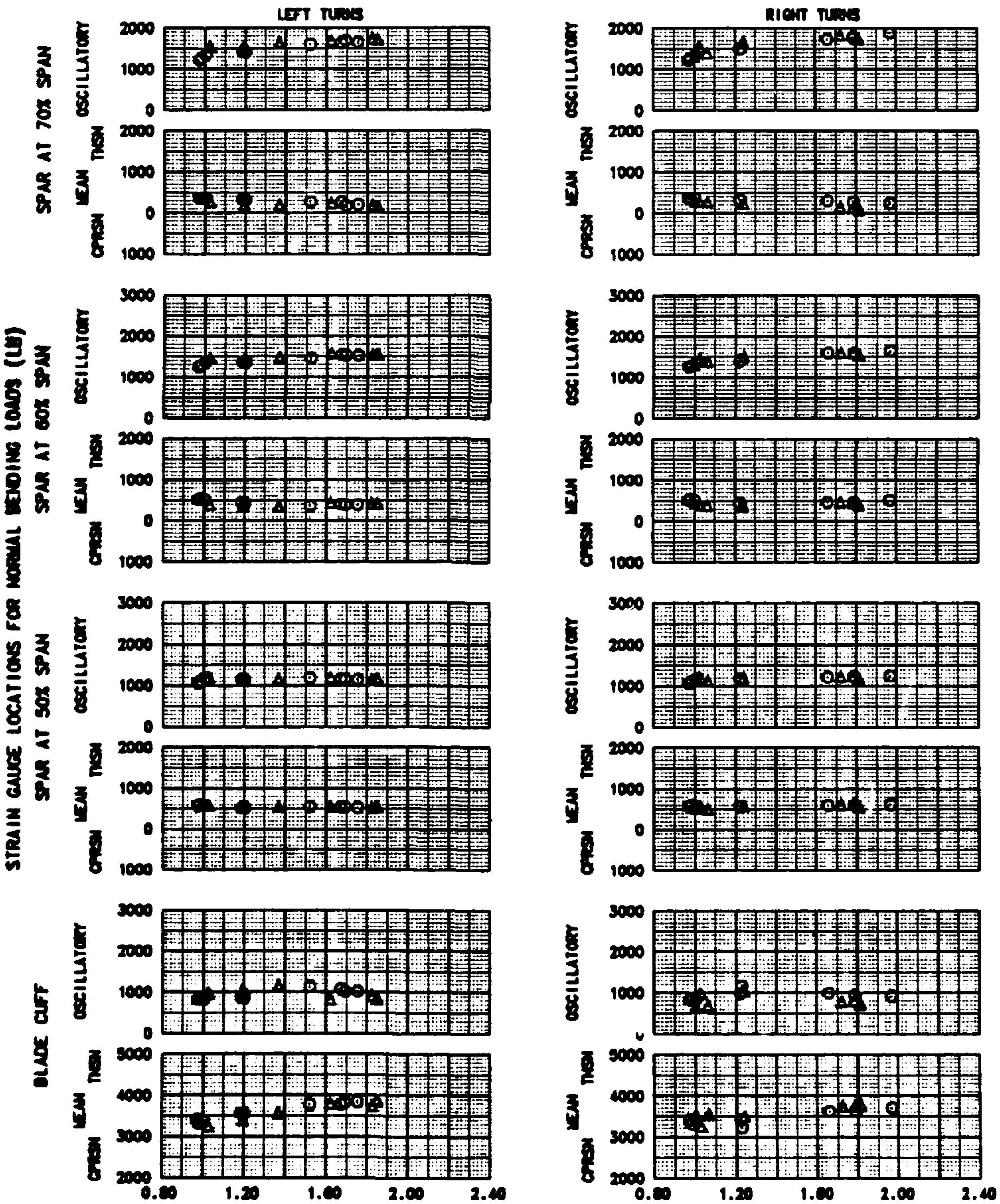


FIGURE E-116
MAIN ROTOR SPAR EDGEWISE BENDING LOADS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15560	361.0(AFT)	5750	12.5	258.5	0.006595
⊙	17080	360.8(AFT)	6930	14.0	258.2	0.007465
△	19040	360.5(AFT)	6900	15.5	258.5	0.008252

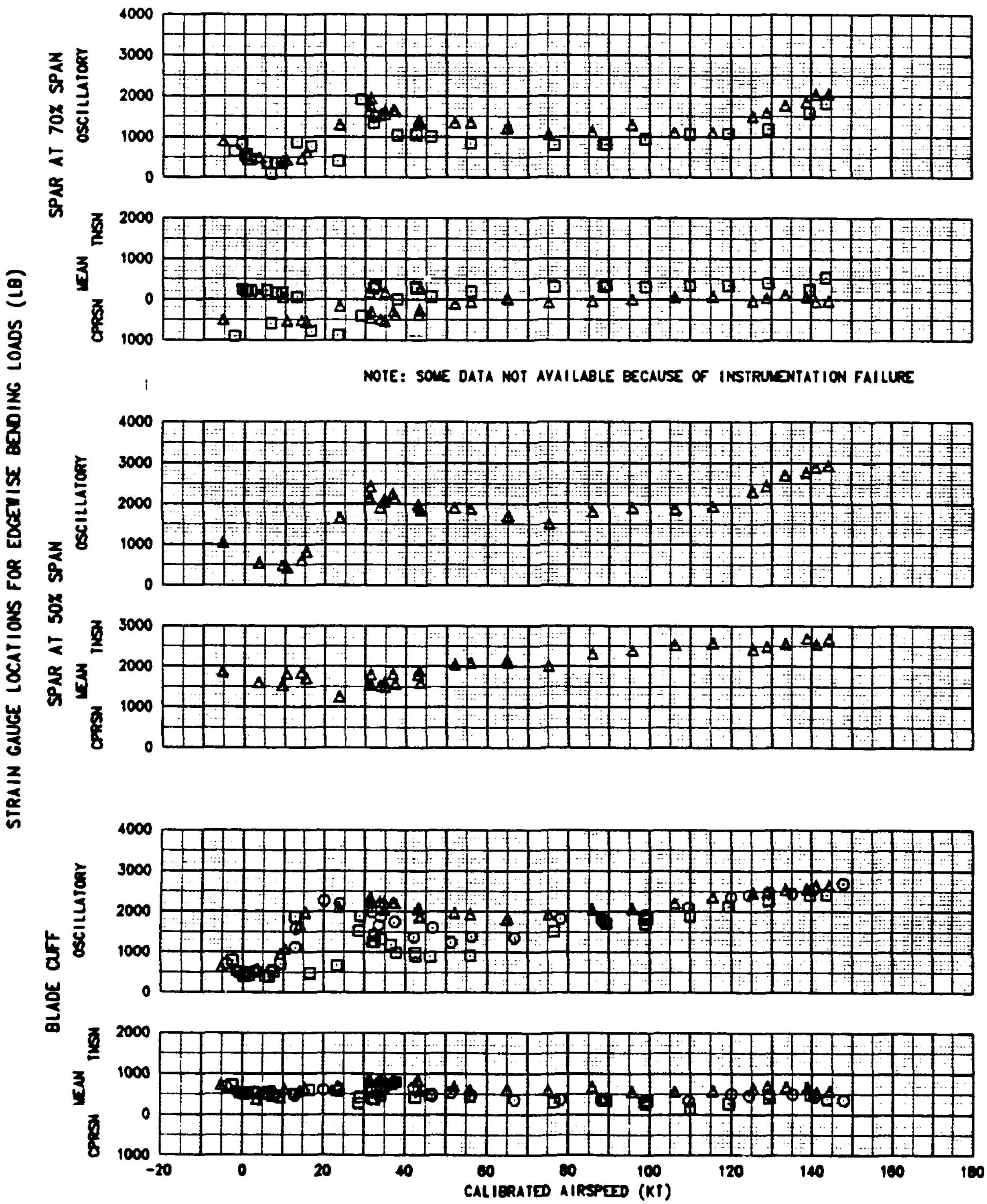


FIGURE E-117

MAIN ROTOR SPAR EDGEWISE BENDING LOADS IN CLIMBS AND POWERED DESCENTS

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	257.3	0.006819
○	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5160	7.0	254.8	0.008209

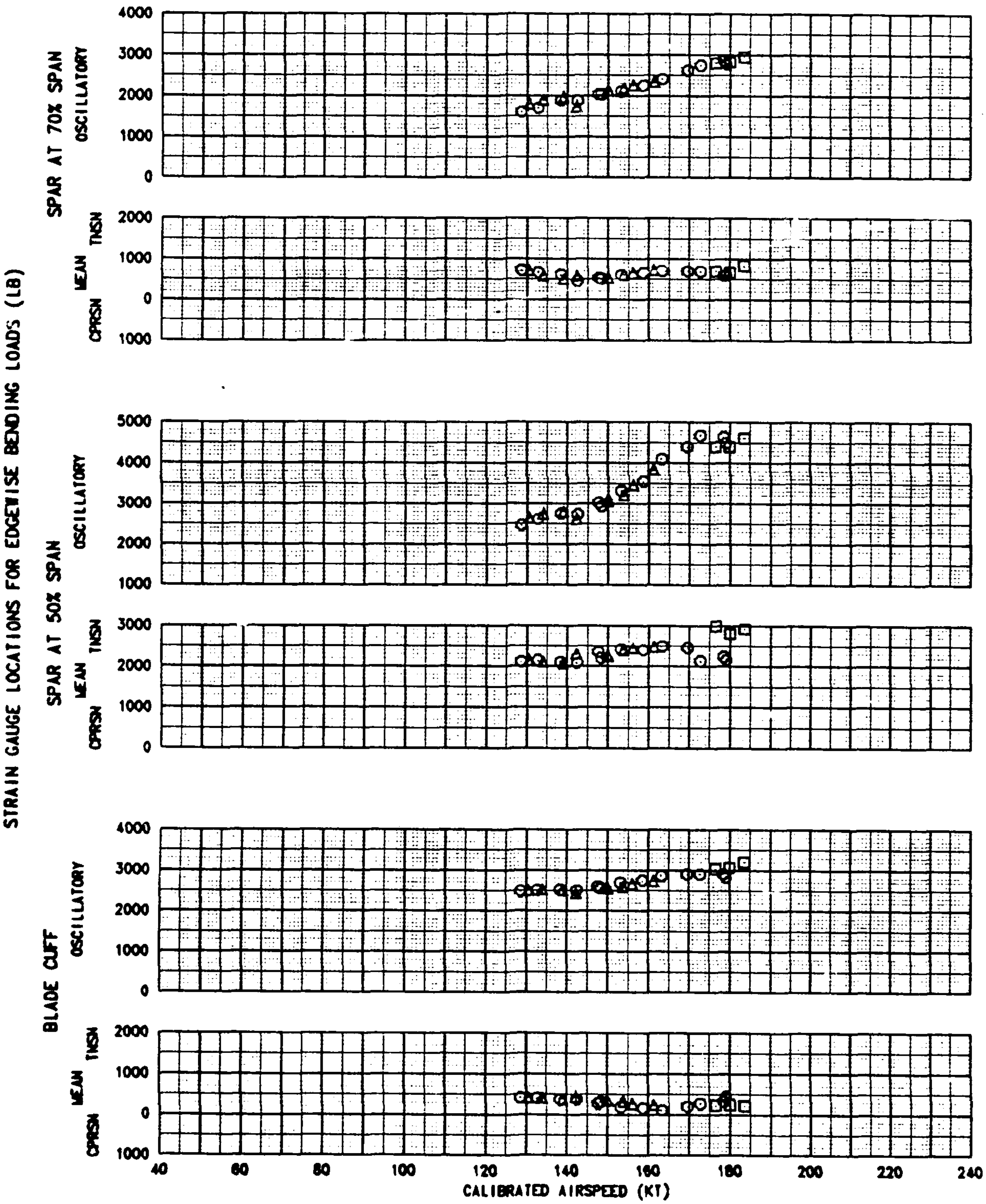


FIGURE E-118

MAIN ROTOR SPAR EDGEWISE BENDING LOADS IN TURNING FLIGHT AT 122 KCAS

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG. ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15540	359.9 (AFT)	6160	14.0	258.2	0.006600
⊙	16140	360.7 (AFT)	8130	8.0	254.7	0.007486
△	17790	360.6 (AFT)	7900	8.5	255.1	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

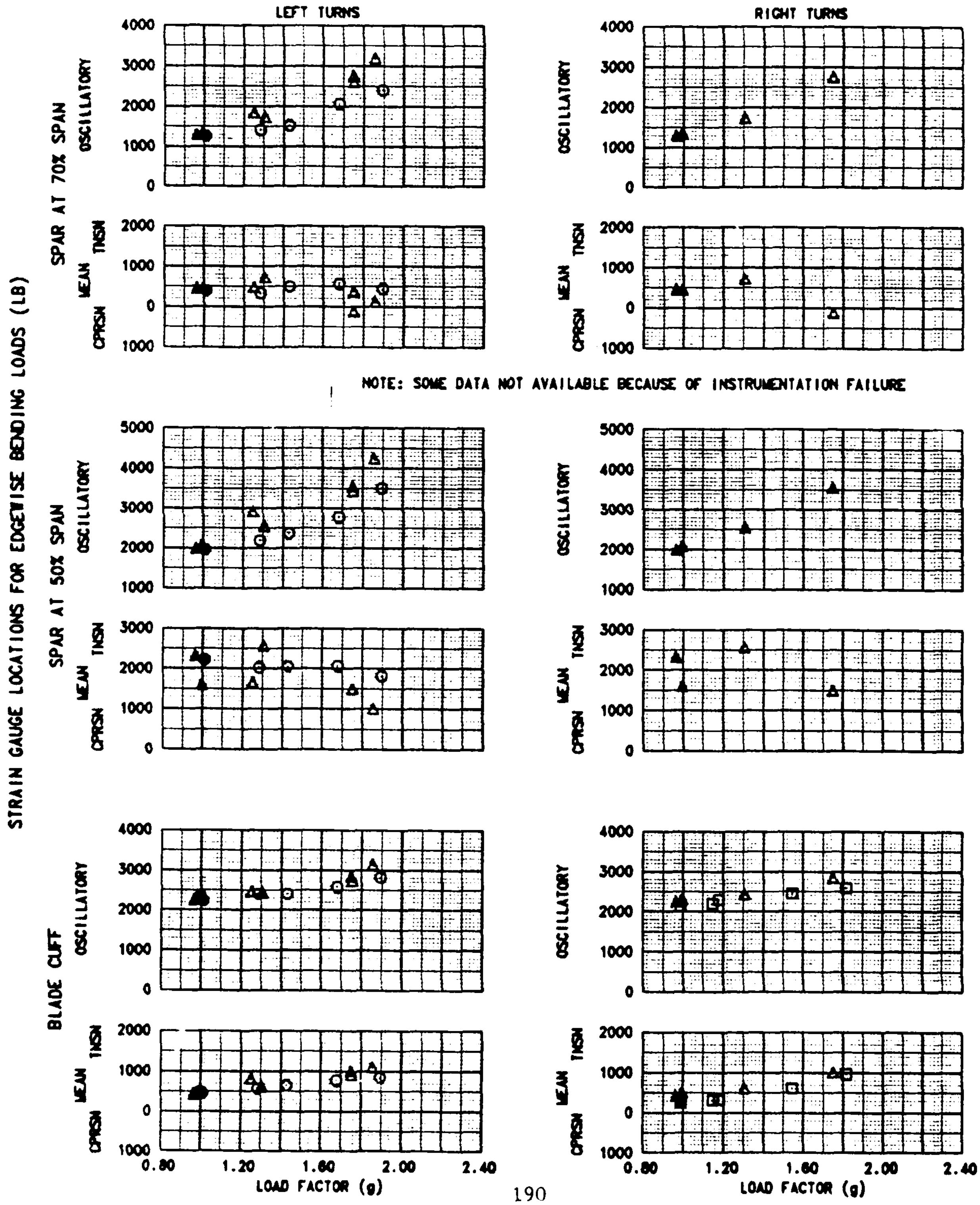


FIGURE E-119

MAIN ROTOR SPAR EDGEWISE BENDING LOADS IN TURNING FLIGHT AT 140 KCAS

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15700	361.1 (AFT)	?150	6.0	254.5	0.007458
△	17570	360.7 (AFT)	8000	3.0	252.6	0.008251

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

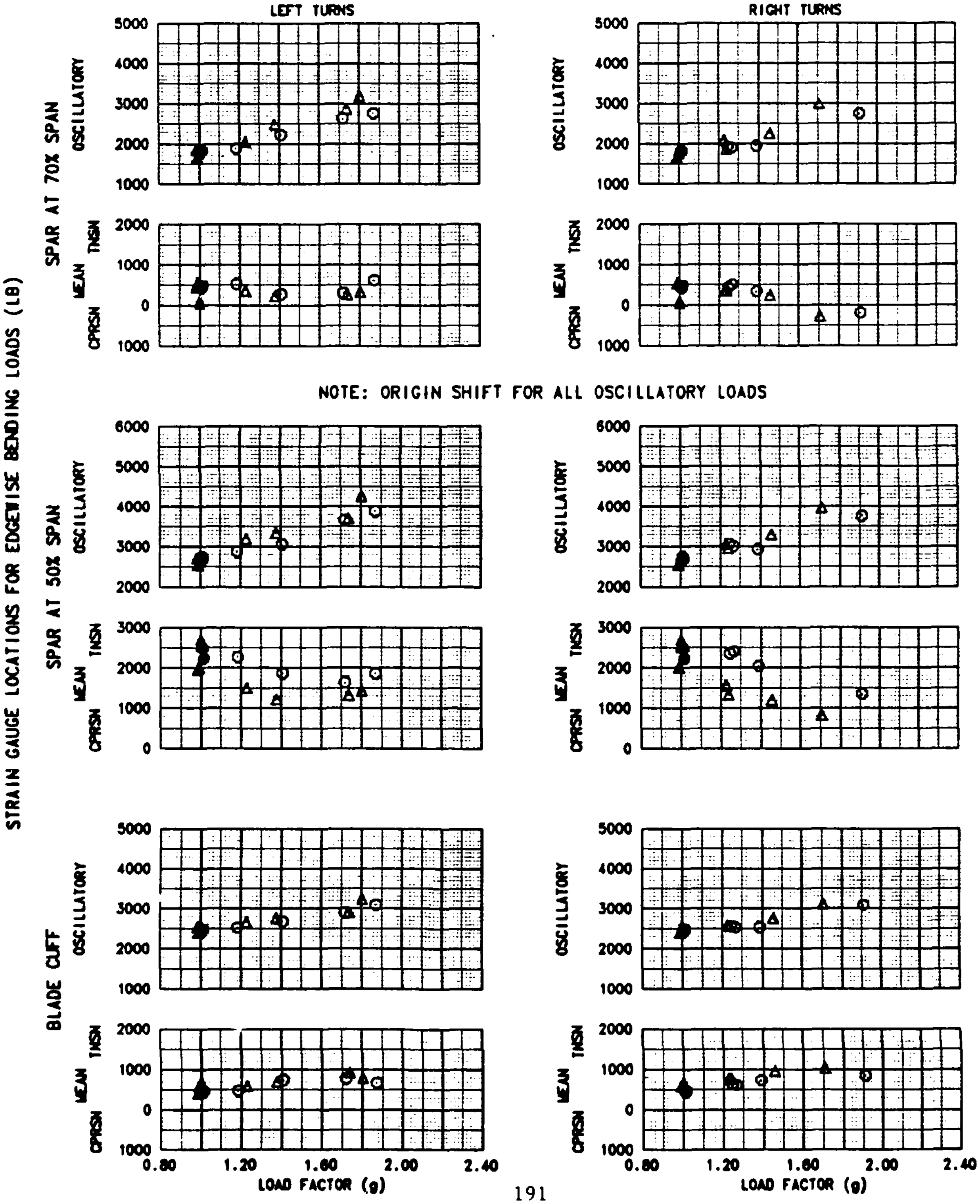


FIGURE E-120
MAIN ROTOR SPAR EDGEWISE BENDING LOADS IN TURNING FLIGHT 150 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15610	361.2 (AFT)	8820	6.5	254.2	0.007426
△	17200	360.7 (AFT)	8380	1.0	251.1	0.008271

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

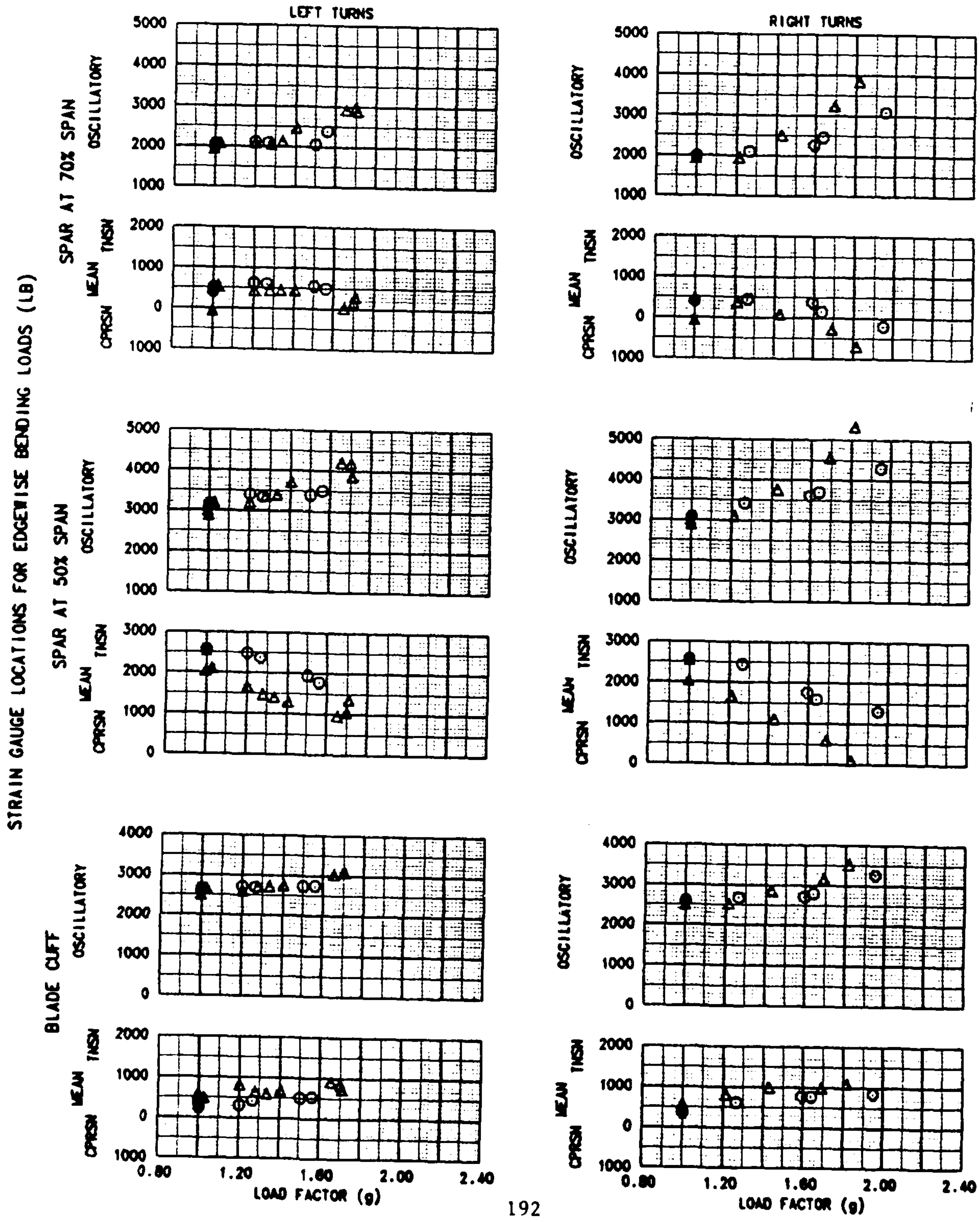


FIGURE E-121
MAIN ROTOR SPAR EDGEWISE BENDING LOADS IN TURNING FLIGHT AT 160 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
O	15920	360.7 (AFT)	8600	8.0	255.5	0.007451
Δ	17100	360.8 (AFT)	9080	4.5	253.0	0.008279

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

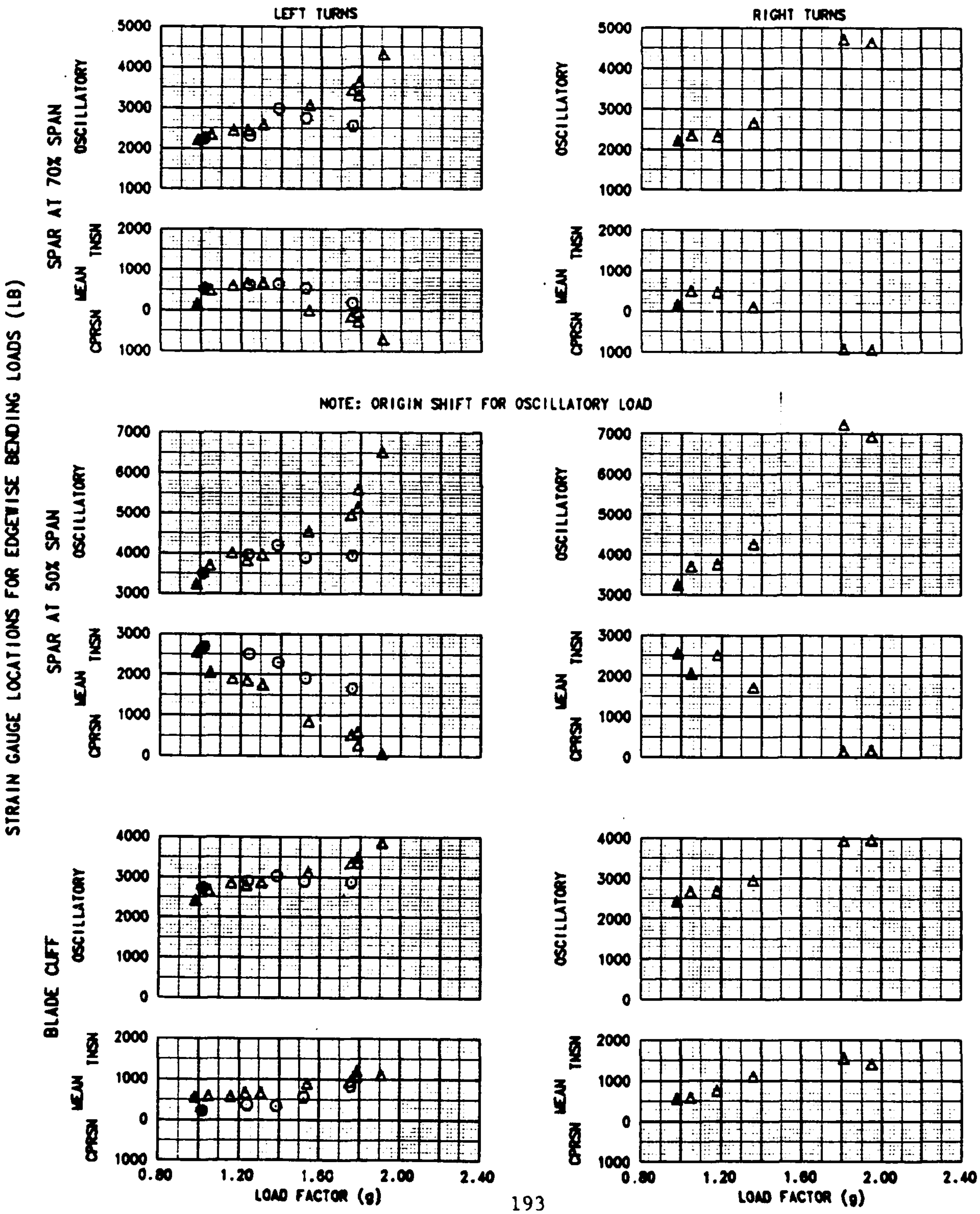


FIGURE E-122
MAIN ROTOR SPAR EDGEWISE BENDING LOADS IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15400	361.5 (AFT)	9040	8.6	253.6	0.007388
△	17280	361.6 (AFT)	9130	9.0	254.8	0.008260

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

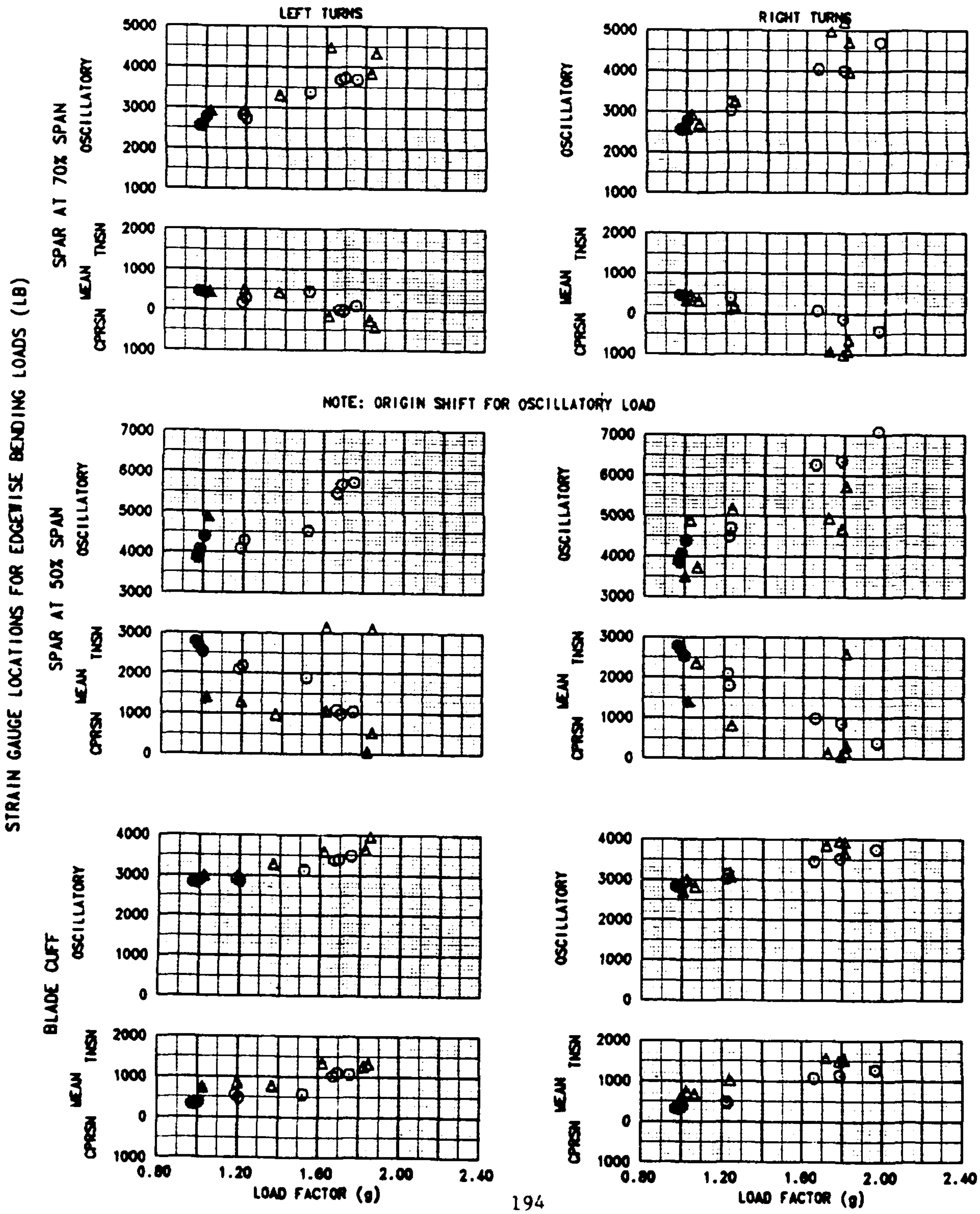


FIGURE E-123
MAIN ROTOR SPAR (AFT LOWER CORNER) STRESS IN LEVEL FLIGHT
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15560	361.0(AFT)	5750	12.5	258.5	0.006595
○	17080	360.8(AFT)	6930	14.0	258.2	0.007465
△	19040	360.5(AFT)	6900	15.5	258.5	0.008252

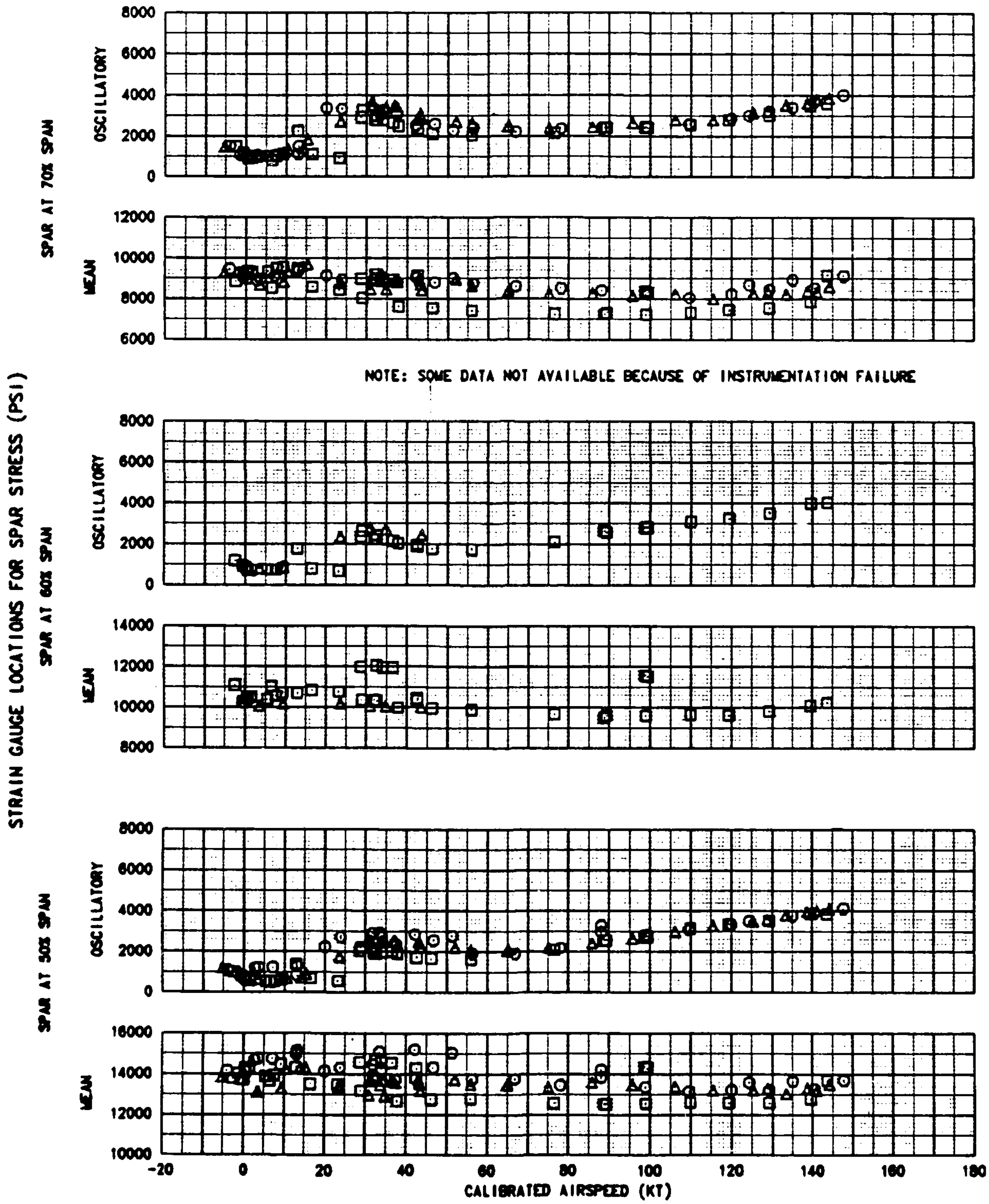


FIGURE E-124
MAIN ROTOR SPAR (AFT LOWER CORNER) STRESS IN CLIMBS AND POWERED DESCENTS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15570	361.3(AFT)	5960	13.0	257.3	0.006619
○	17330	360.9(AFT)	5400	6.0	254.9	0.007379
△	19400	361.1(AFT)	5160	7.0	254.8	0.008209

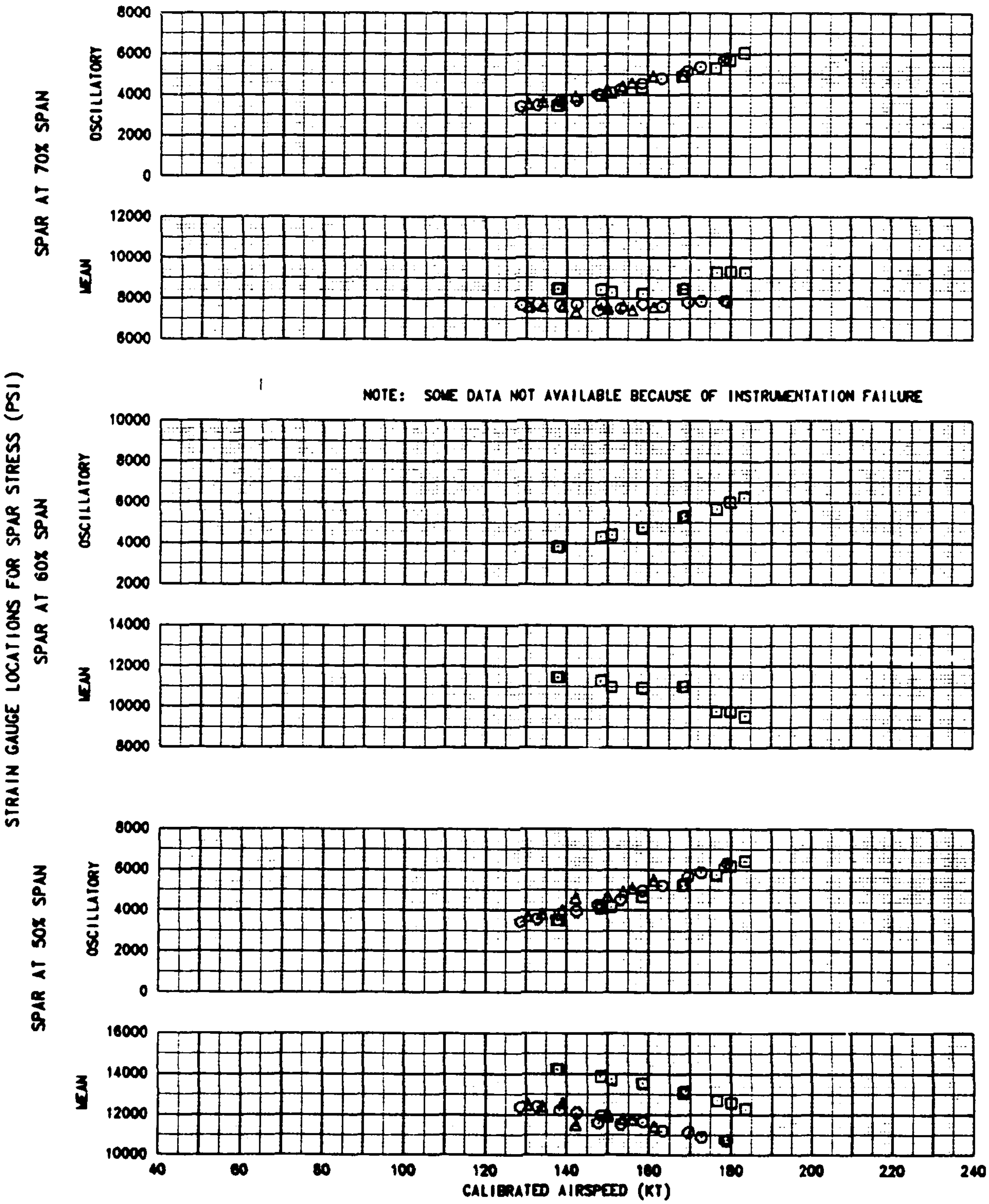


FIGURE E-125
MAIN ROTOR SPAR STRESS (AFT LOWER CORNER) IN TURNING FLIGHT AT 122 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
□	15540	359.9 (AFT)	6140	14.0	258.2	0.006600
○	16140	360.7 (AFT)	8180	8.0	254.7	0.007487
△	17790	360.6 (AFT)	7900	8.5	255.1	0.008159

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

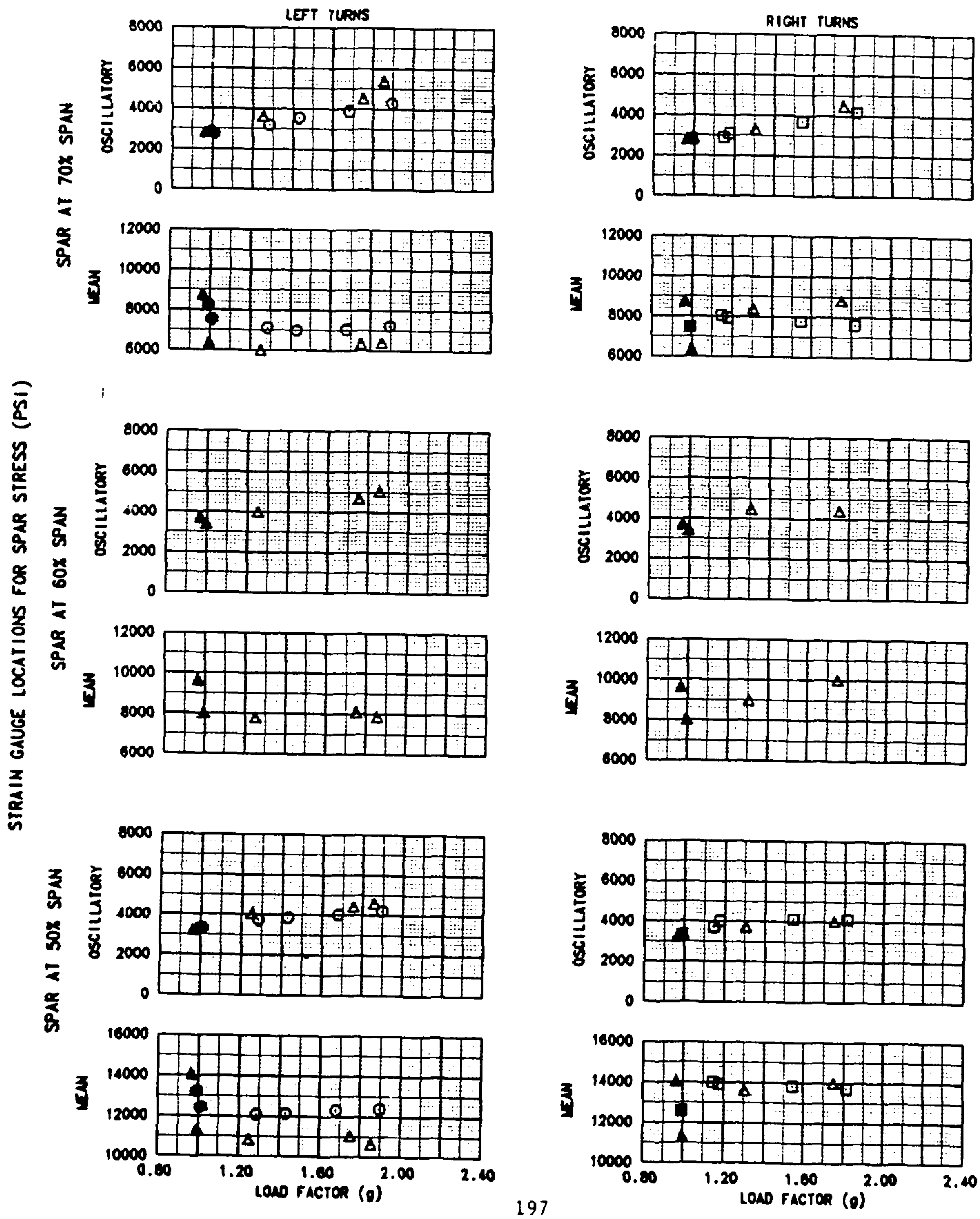


FIGURE E-126

MAIN ROTOR SPAR STRESS (AFT LOWER CORNER) IN TURNING FLIGHT AT 140 KCAS

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15700	361.1 (AFT)	8900	6.0	254.5	0.007458
△	17570	360.7 (AFT)	8100	3.0	252.6	0.008251

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

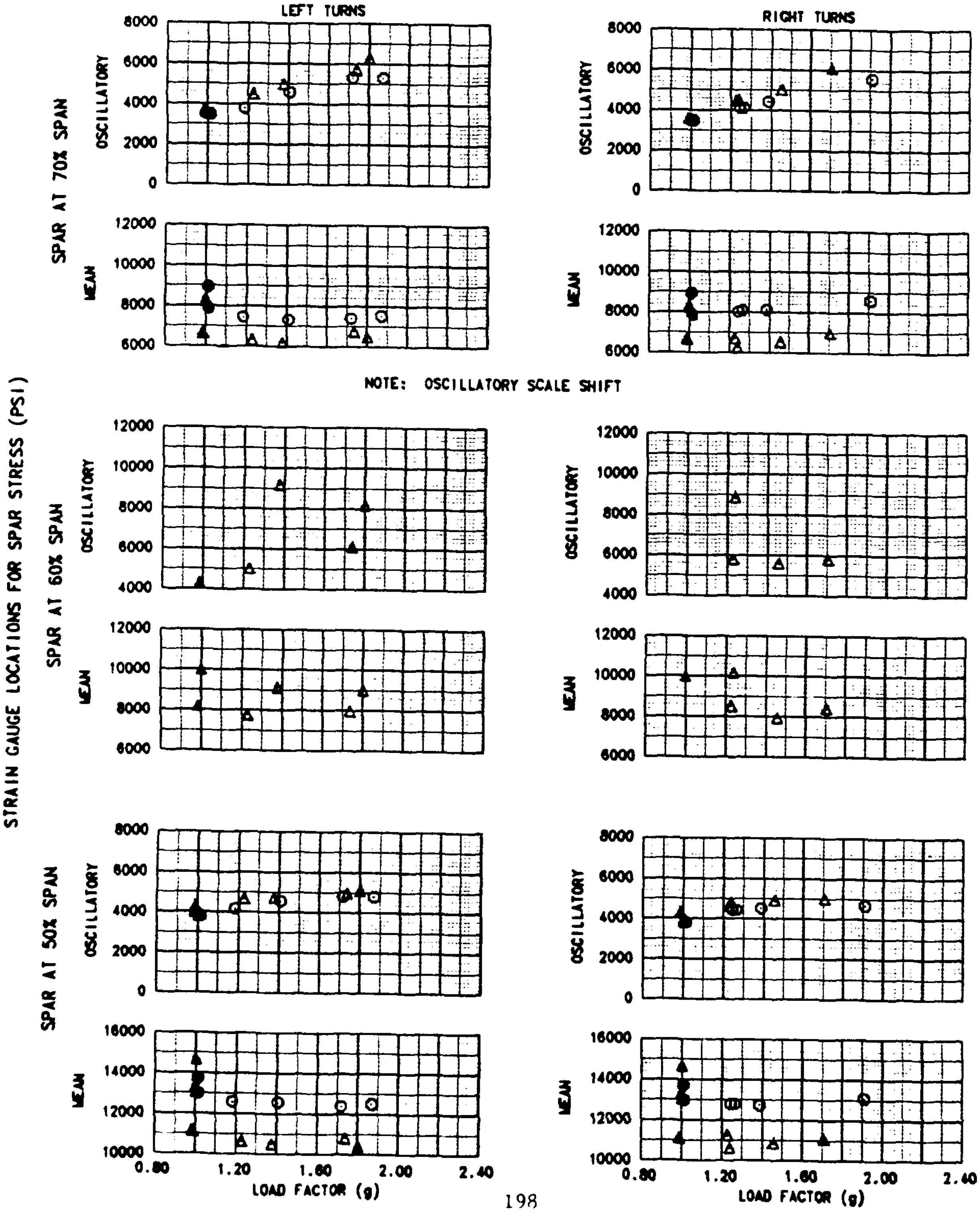


FIGURE E-127

MAIN ROTOR SPAR STRESS (AFT LOWER CORNER) IN TURNING FLIGHT AT 150 KCAS

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15610	361.2 (AFT)	8870	6.5	254.2	0.007424
△	17200	360.7 (AFT)	8470	1.0	251.1	0.008271

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

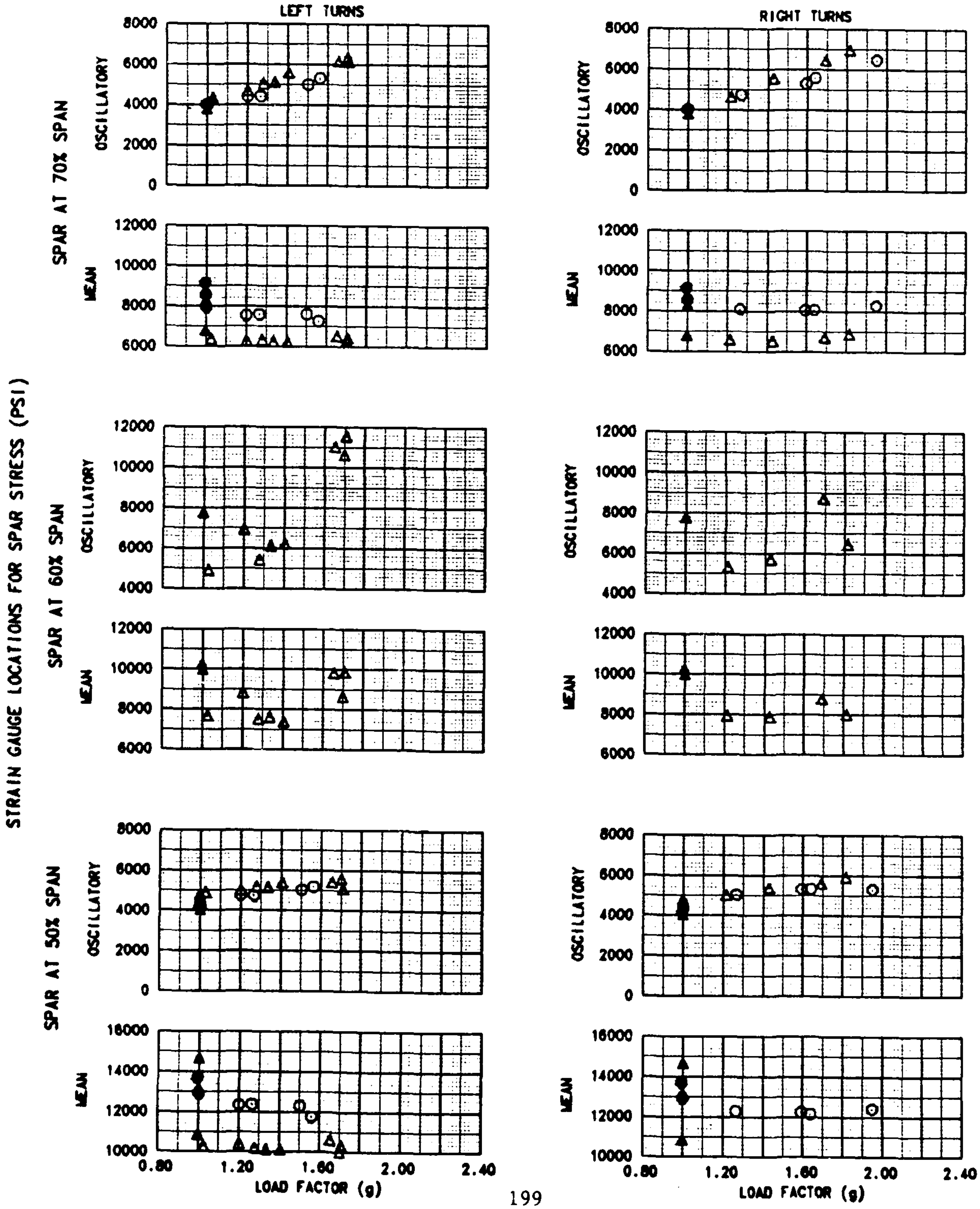


FIGURE E-128

MAIN ROTOR SPAR STRESS (AFT LOWER CORNER) IN TURNING FLIGHT AT 160 KCAS

UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15920	360.7 (AFT)	8600	8.0	255.5	0.007451
△	17100	360.8 (AFT)	9080	4.5	253.0	0.008279

NOTES:
1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT

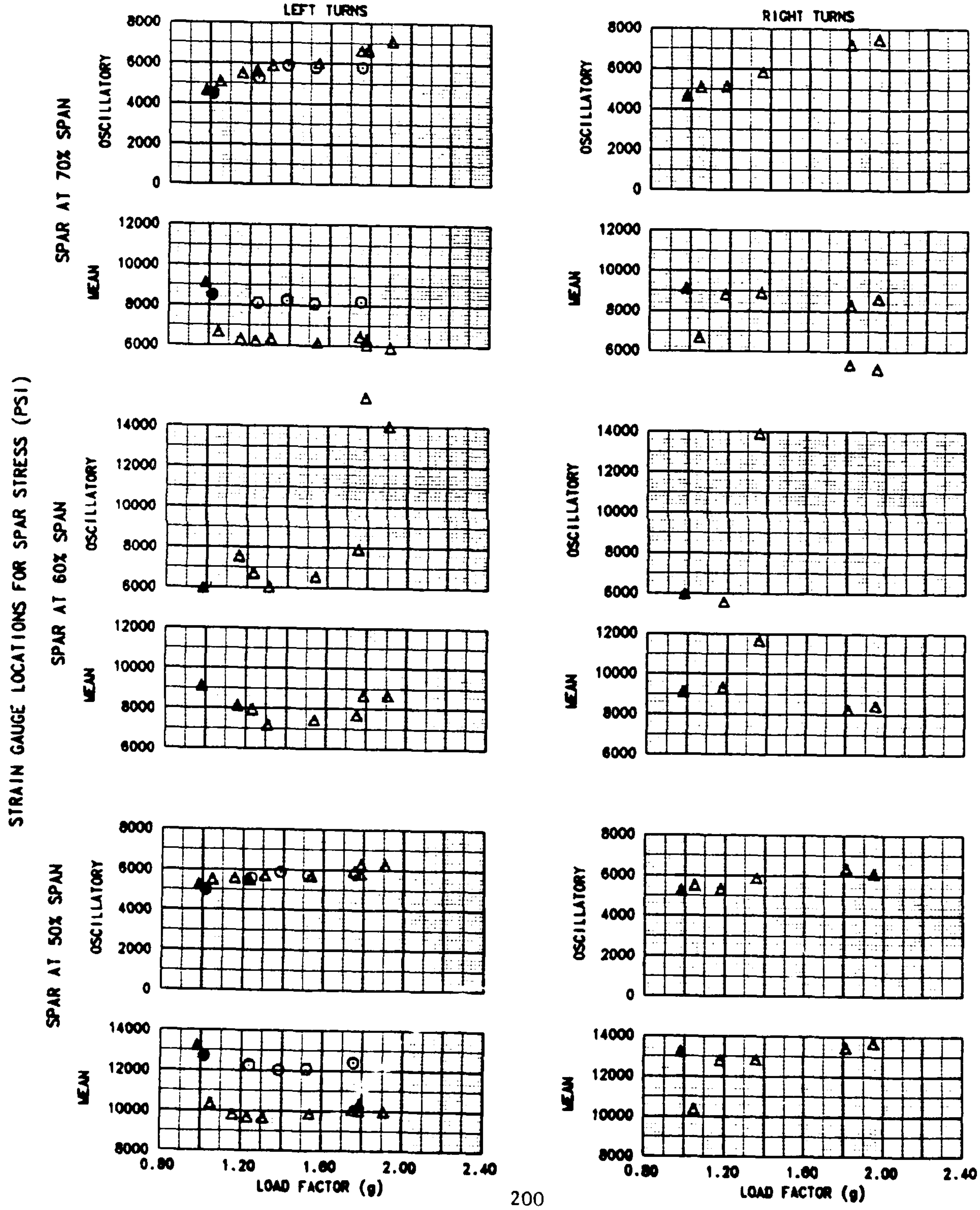
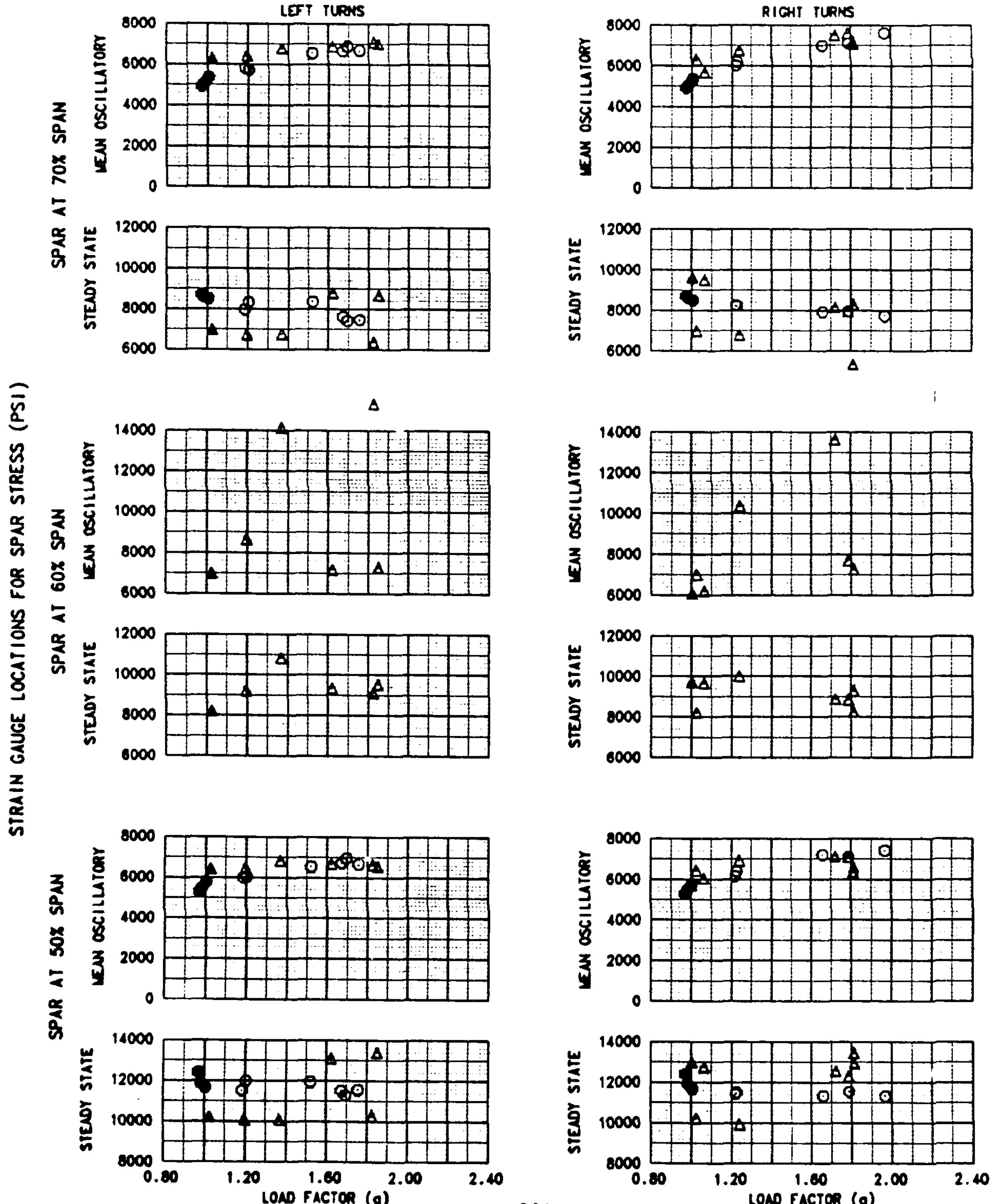


FIGURE 129
MAIN ROTOR SPAR STRESS (AFT LOWER CORNER) IN TURNING FLIGHT AT 171 KCAS
UH-60A USA S/N 82-23748

SYM	AVG GROSS WEIGHT (LB)	AVG LONGITUDINAL CG (FS)	AVG DENSITY ALTITUDE (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG THRUST COEFFICIENT
○	15400	361.5 (AFT)	9040	8.6	253.6	0.007388
△	17280	361.6 (AFT)	9130	9.0	254.8	0.008260

NOTES: 1. SHADED SYMBOLS DENOTE TRIM POINT
2. DATA OBTAINED USING POWER FOR LEVEL FLIGHT OR INTERMEDIATE RATED POWER AT AIRSPEEDS ABOVE THE MAXIMUM AIRSPEED FOR LEVEL FLIGHT



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